

# CROSSBAR DIAL SYSTEM

## SECTION III - CROSSBAR SYSTEM CIRCUITS

### PART I - ORIGINATING CIRCUITS

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## SECTION III - CROSSBAR SYSTEM CIRCUITS

### CHAPTER 13 - CROSSBAR CIRCUIT FEATURES

#### CHAIN RELAY CIRCUITS

Chain relay circuits are used extensively and are very vital to the crossbar system. Consequently a brief description of their operation is being given at the beginning of our circuit study. Some chain relay circuits are used to recognize simultaneous attempts to place calls at various points in the system. Other chain relay circuits are used to indicate idle paths or channels and to prefer a particular one of those available. These chain circuits then determine which call shall be served first or which path shall be used. In some cases the calls that were locked out will then try to use other channels available through other chain circuits.

#### DOUBLE TRANSFER RELAY CHAIN

Fig.1 shows a double transfer relay chain. These relays are used by the marker circuits to obtain access to the district link frame, practically the same chain circuit is used on the office and incoming link frames, the two marker connectors, the number group and line choice connectors. This type of chain circuit gets its name from the 1, 2, 3B contacts which transfer the operating circuit of the relay to a locking circuit and from the 1, 2, 3T contacts which transfer the functional circuit, so that the operation of only one relay in the chain is effective. If one call is originated at a time it is handled without delay, the "A" lead advancing the circuit to perform its usual function. It should be noted that the relay to the right is the preference relay whenever there are simultaneous calls and of course the associated marker is able to handle its call whenever it can operate its marker preference (MP) relay. The preference relay is determined by the relay to which the "A" and "B" grounds are directly connected.

First, assume that a call is using the right hand, first, (MP) relay. Either or both of the intermediate or last (MP) relays may operate while the first (MP) relay is in use; however, due to the opening of the "A" ground at contact 3T of the first (MP) relay no harm is done since the markers cannot obtain access to the frame. When the call through the first (MP) relay is completed and the relay released and assuming calls have been originated to operate both of the other (MP) relays, the second or intermediate (MP) relay will now have a ground on its "A" lead and may thus complete its call while the last marker is still held back due to the opening of the 3T contact of the intermediate (MP) relay. Should another call come in on the first marker

for this particular frame it cannot operate its (MP) relay since its operating circuit is open at the 3B contact of intermediate (MP) relay. Thus it may be seen that a chain relay which has the preference cannot operate as long as a relay preferred later is operated. The relays which are preferred later may operate while a relay having the preference is in use and thereby those out of preference will be served before one in preference can serve a second call. When the relay last in preference releases, and assuming a call waiting on all other markers, it is the intention that all relays should operate simultaneously. This requires that the slowest operating relay will close its locking contact 2B before the operating contact 3B of the fastest relay is opened. This type of relay chain circuit in a modified form is used extensively throughout the entire crossbar system.

#### END RELAY CHAIN CIRCUIT

Fig.2 shows one use of an end relay chain circuit. The particular circuit illustration is used for testing to determine which line in a group of ten lines is originating a call. Ground from line (L0) relay operates the line test (LT-0) relay. The (LT-0) relay locks and operates the (RE) relay. The (RE) relay in turn operates the line selected (LS) relay which provides a locking ground for the (LT-) relay and operates the line end (LE) relay. The (LE) relay in operating opens the operating circuit to all (LT-) relays. Consequently the subsequent operation of other (L-) relays cannot in any way interfere with the functioning of the circuit as long as the (LE) relay is operated. Should two other calls be originated while the one call is being served then as the (LS) and (LE) relays release, the two (LT-) relays should operate simultaneously. One (LT-) relay may be fast and the other slow; however, in this case both (LT-) relays should operate, especially since considerable time is allowed for the slow (LT-) relays to operate. The fast (LT) relay must operate, in turn operating the (RE), (LS), and (LE) relays, before the operating circuit is opened to the slow (LT-) relay. Assume the (LT-4) and (LT-9) relays are operated and the (RE), (LS), and (LE) relays operate. In this case only the (LT-4) relay locks and the (LT-9) relay releases. In this case the (LT-4) relay is the preferred relay as determined by the locking transfer contacts of the chain relays. Only one of the chain relays is operated during the remainder of the time the call is being established. Other contacts on these (LT-) relays are used to perform various functions and, since only one relay is operated during the period these contacts are effective, simple make contacts are satisfactory. Otherwise

## CROSSBAR CIRCUIT FEATURES

it would be necessary to provide transfer contacts in place of make contacts and to wire the transfer contacts in a chain arrangement as indicated for the bottom transfer contacts used to operate the (RE) relay.

An end relay chain circuit is used as the district group selection chain involving the (G) relays in the line link. The sender group (SG) and the district (D) relays in the sender link are also end relay chains. The (SG-) relays have an added feature, which is provided to check that one and only one (SG) relay is operated after the end relay is operated. This is used as an added safeguard to avoid the possibility of trouble in the relays causing two groups of senders to be seized.

A modification of the end relay chain is used to determine the horizontal group preference in the line link in case several calls are originated simultaneously in more than one horizontal group of one line link frame, and to permit one call to be served in each horizontal group before calls originated later are served. This necessitates that all chain relays which are operated at the time the end or gate (GTA) relay is operated, must lock, consequently chain contacts must be provided on all these chain relays.

Numerous other applications of both the double transfer chain relays and end chain relay circuits are used in the crossbar system and should be recognized as such whenever encountered.

### TESTING FOR IDLE CHANNELS

The circuit used for testing for an idle channel between a district junctor, used in originating a call, and a desired outgoing trunk is shown on Fig. 3. In this circuit the originating marker has seized the office link frame, has tested and found an idle outgoing trunk and has operated the link connector (LC) relay associated with the selected trunk. This connects through the link sleeve "LS" leads of twenty office links to the marker for test, one from the left half of each primary switch and one from the right half of each primary switch.

The marker has also seized the district link frame associated with the district junctor and through the originating sender has connected the district junctor to the district link and operated its associated link connector (LC) relay. In a manner similar to the (LC) relay of the office link, this (LC) relay closes through the link sleeve "LS" leads of the twenty district links which may serve the district junctor calling.

The marker has also operated the junctor connector (JC) relay associated with the office junctors connecting the district and office link frames involved in this call. This connects through the sleeves of the office junctors to the marker for test. Each (JC) relay closes through the sleeve "S" leads of a maximum of twenty office junctors, one from the left half and one from the right half of each district link secondary switch to the associated left and right

halves of office link primary switches if there are ten district link frames and office link frames.

A channel is a path between the selected trunk and the district junctor. If the office secondary multiple is split, then there is a maximum of ten channels from each trunk to any district. If the trunk is on the left half of the switch, the ten channels will go through the left halves of the four switches, district link primary and secondary and office link primary and secondary switch. There will be one channel through each of the district link secondary and office link primary switches. If the trunk is on the right half of the office link secondary switch then the channels use the right halves of the four switches. If the office link secondary switch multiple is not split, then the links on both the right and left halves of switch are available. Consequently, there are twenty channels available to establish a connection between the trunk and district junctor.

The three test leads "LS", "S", and "LS" of each channel are connected to a pair of (AB) and (C) relays. The three paths which form a channel are referred to as "A", "B", and "C" links. "A" refers to the district link, "B" to the office junctor and "C" to the office link. The (AB) and (C) relays can be considered as a single relay with a single transfer contact which is used in a chain circuit with other similar relays. If any one of the links in the channel is busy the (AB) or (C) relay operates and the channel cannot be used for this call. Under this condition the chain circuit advances the preference on to the next relay in the line of preference. If the three links in the channel are all idle then the channel may be used and the associated channel (CH-) relay is operated.

The (CH-) relay operated closes the three test leads through to another portion of the marker to be used later in operating the four hold magnets in the channel to establish the connection.

It should also be noted that the (C) relay has two windings. One winding is connected to the "C" office link while the second winding is used for "blanking" out a channel in a pattern arrangement by operating a pattern relay or, in case the multiple of the office secondary is split, one half of the twenty channels to the office secondary switch must appear busy by being blanked out. This is accomplished by the use of the split left (SPL) or split right (SPR) relay.

### FUNDAMENTAL CIRCUIT

The reverting pulsing fundamental circuit is shown on Fig. 4. By means of this circuit, the numerical digits of the called number are transmitted from the originating sender to the terminating sender. When the originating sender closes the fundamental for incoming brush selection, the incoming trunk and terminating sender function to close the tip and ring of the trunk to the terminating sender line (L) and stepper (STP) relays through the contacts of the operated (ONL) relay.

The (L) relay operates in turn operating the (L1) and (L2) relays permitting the (STP) relay to operate. The (STP) relay in the originating sender also operates in series with the (L) relay. The operation of this (STP) relay operates a counting relay. Assume 5 thousands crosspoint is closed, then (2) counting relay operates. The (2') relay does not operate until the (STP) relay releases having ground on both sides of its winding.

The terminating sender (STP) relay operating operates the (GR) relay, which grounds the tip (revertive pulse) of the circuit holding the (L) relay and shunting both (STP) relays. The release of the (STP) relay in the originating sender permits the (2') relay to operate and transfer the circle 2 lead to the (1) relay. The release of the (STP) relay in the terminating sender releases the (GR) relay in turn removing the ground pulse from the tip of the circuit. Both (STP) relays again operate. The functioning of these relays is shown below:

Orig. Sdr. (STP)	Ctg. Rel. Oper.	(L) Rel.	Term. Sdr. (STP)	(GR) Rel.	Revertive Pulse
Oper.	(2)	Oper.	Oper.	Oper.	Closed
Rel.	(2')	Held	Rel.	Rel.	Opened
Oper.	(1)	Held	Oper.	Oper.	Closed
Rel.	(1')	Held	Rel.	Rel.	Opened
Oper.	(0)	Held	Oper.	Oper.	Closed
Rel.	(B0) (F0)	Held	Rel.	Rel.	Opened
-	-	Rel.	-	-	-

The operation of the (F0) relay in the originating sender causes the sequence relays to switch from the incoming brush selection circuit to the incoming group selection circuit, in so doing releasing the counting relays. The tip and ring circuit is not closed again by the originating sender until the terminating sender has had time to record the selection.

The (GR) relay operates and releases once for each operation and release of the originating (STP) relay, consequently the selection, number of pulses sent by the originating sender may be recorded in the terminating sender by counting the operations of the (GR) relay in a manner very similar to that used in counting the subscriber dial pulses in the originating sender. The (GR) relay is used to effectively add contacts to the (STP) relay and is slow operating and slow releasing so as to insure that the combined operating time of the terminating (STP) and (GR) relays will exceed that of the originating (STP) and counting relays and that the combined releasing time of the terminating (STP) and (GR) relays will exceed that of the releasing time of the originating sender (STP) relay and the operation of the prime counting relay.

The terminating (L) relay releases due to the opening of the fundamental circuit by the (B0) relay and the release of the (GR) relay. The release of the (L), (L1), and (L2) relays cause the pulse counting and steering relays to function to record the incoming brush selection just received and switch the circuit in preparation for receiving and recording incoming group selections. The above operation is repeated for the remainder of the selections.

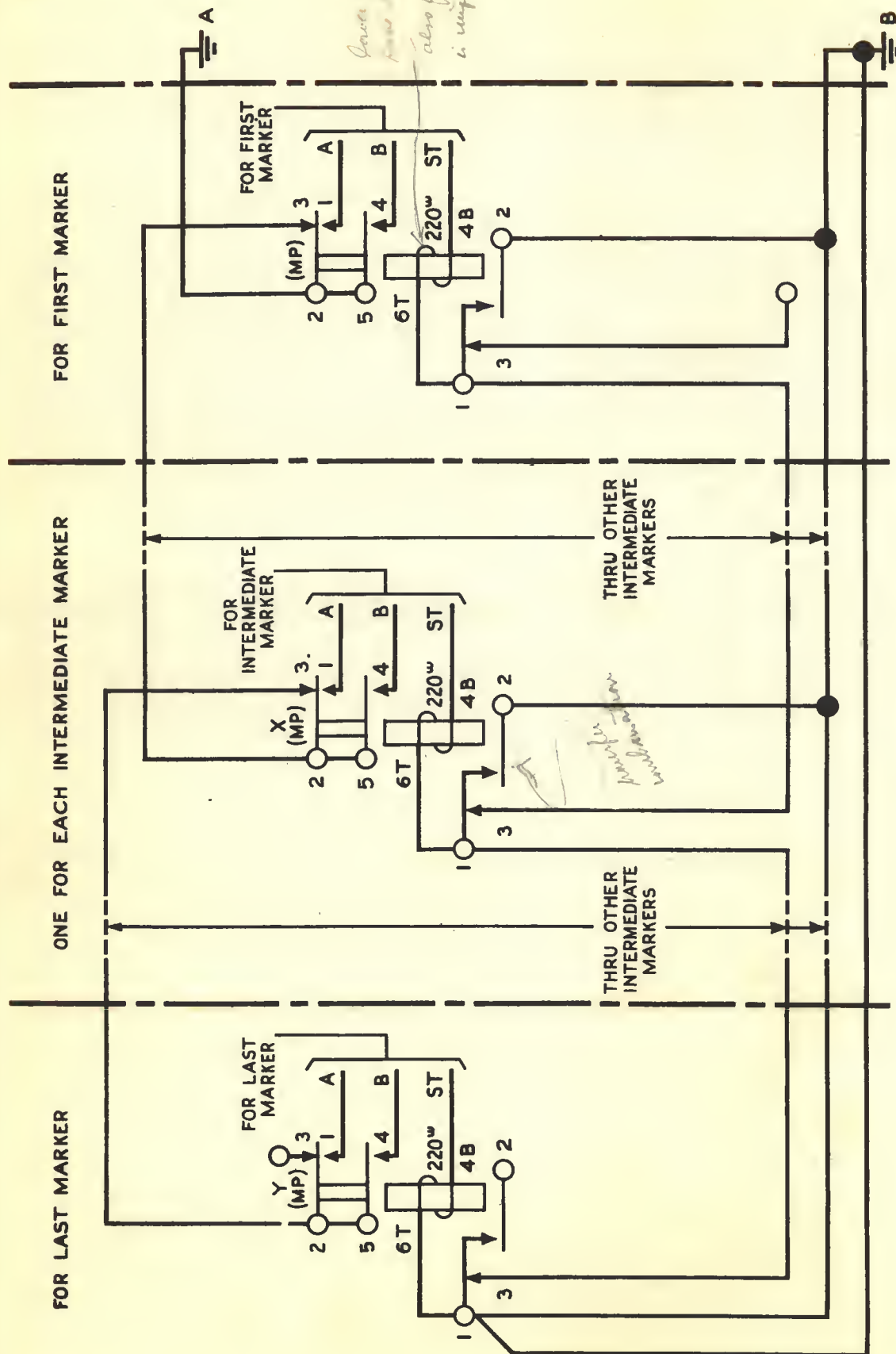


Fig. 1 - Double Transfer Chain Circuit

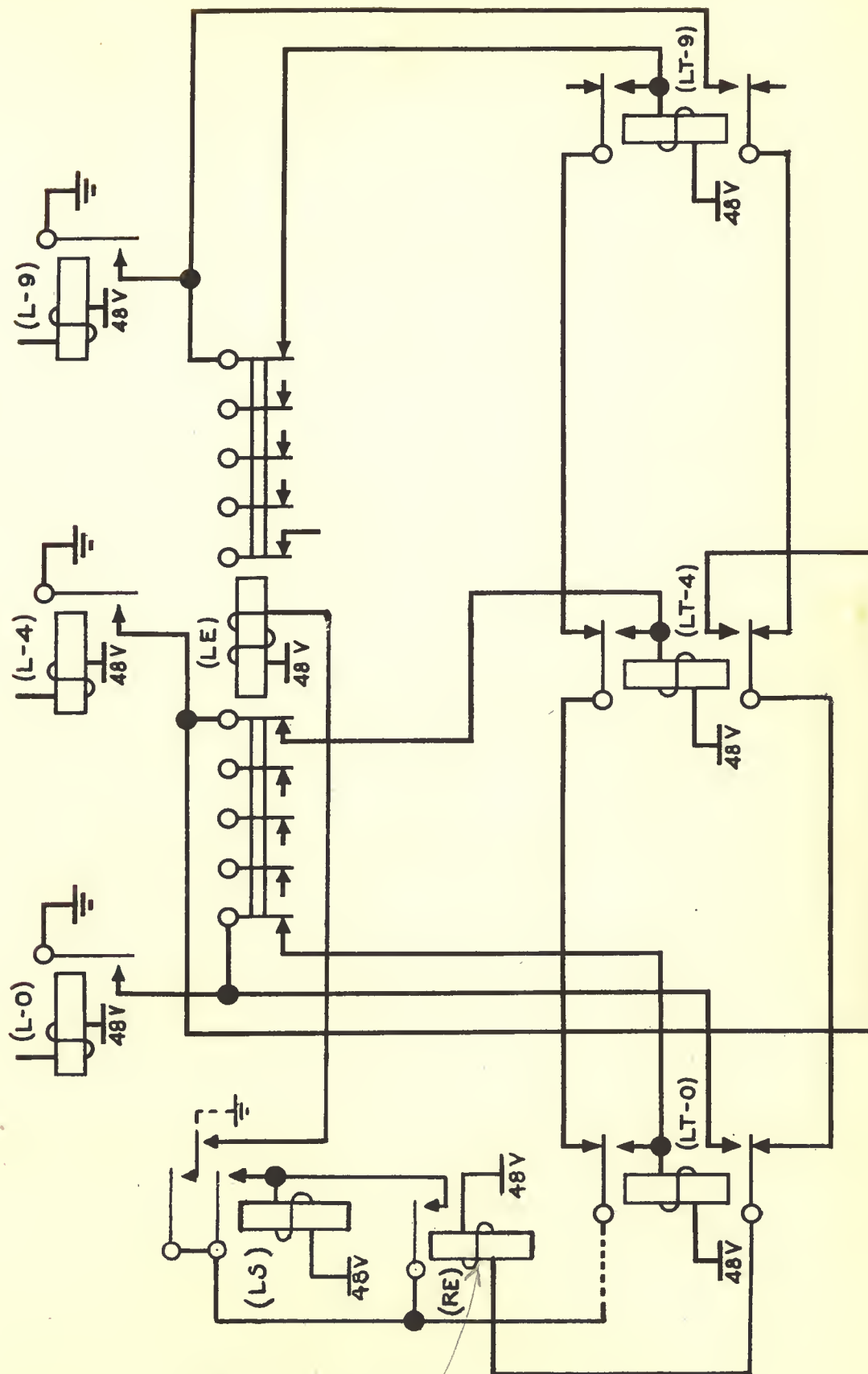


Fig. 2 - End Relay Chain Circuit



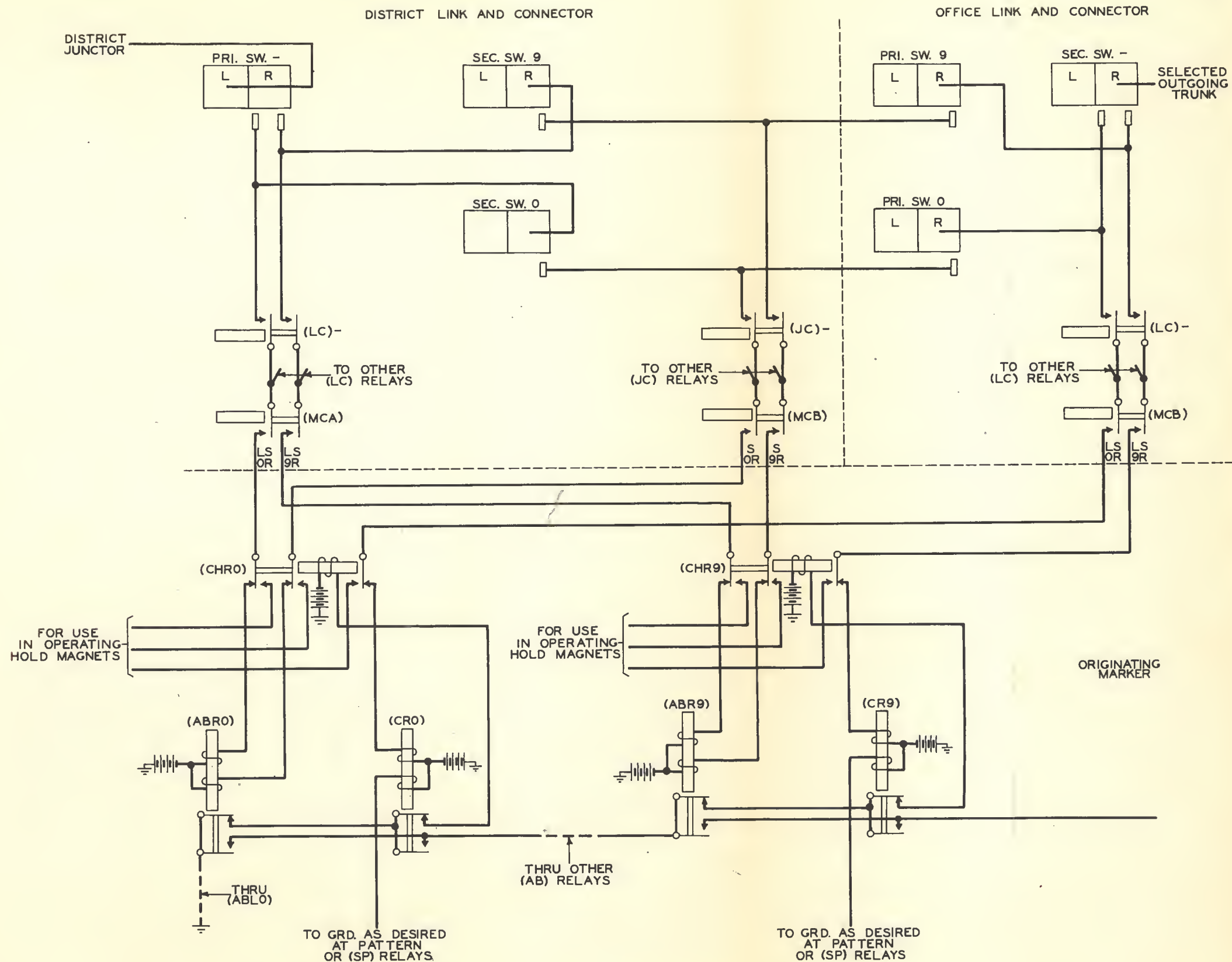


Fig. 3 - Channel Test



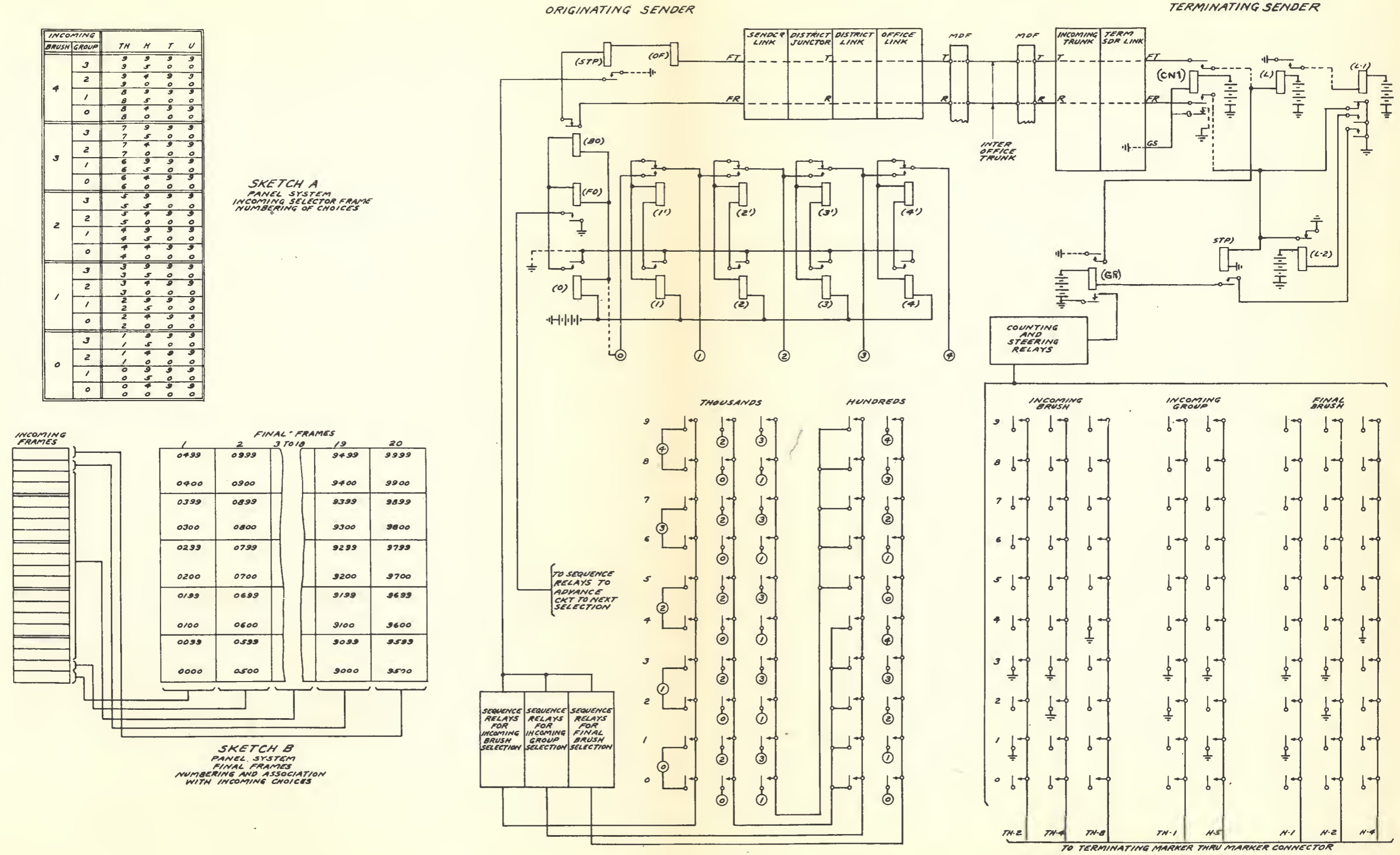


Fig. 4 - Terminating Sender - Fundamental and Pulsing Circuit - Incoming Brush, Incoming Group and Final Brush Selections



## CHAPTER 14 - CONNECTING SUBSCRIBER SENDER TO CALLING LINE

In describing the operation of the various circuits in the crossbar system, an attempt will be made to cover the various features used in establishing a call regardless of which circuits are involved rather than to describe the various circuits separately. The features will be described in the order in which they are used in establishing a call except where simultaneous operations occur. Sufficient detail is included to obtain a general operating knowledge of the circuits. However, numerous details, which are not essential to an understanding of the crossbar system, are omitted.

### SUBSCRIBER ORIGINATES A CALL

When the subscriber originates a call by removing the receiver from the switchhook the line (L) relay operates, which in turn operates a horizontal (HA) relay operating in turn a (CA) relay for starting the home control circuit as shown on Fig. 1. The (CA) relay operates the frame (FA) relay. The (FA) relay, operates the (AC) relay which cuts in the leads to the home control circuit and operates the gate (GTA) relay.

### HORIZONTAL IDENTIFICATION

If a number of subscribers in different horizontal groups had originated a call before the (GTA) relay had operated, the corresponding horizontal (HA) relay would have operated. The operation then of the (GTA) relay opens the operating circuit to all (HA-) relays. However, the (HA-) relays which were operated, are locked under control of the subscriber line in their corresponding horizontal group. The purpose of this feature is to permit this group of subscribers to have their calls completed before any subscriber who originates a call in another horizontal group after the (GTA) relay was operated. The (GTA) and (CA) relays remain operated between the setting up of the several calls, until one call in each of the horizontal groups associated with the operated (HA-) relays has been served.

### CONTROL CIRCUIT SELECTED

The function of the (CA) relay in conjunction with the (CB) relay, is to determine whether the home or the mate control circuit is to be used. The (CA) relay being faster than the (CB) relay causes the home control circuit to be preferred. If for any reason the (CA) relay is delayed in operating, the (CB) relay will operate under control of an (HB-) relay (not shown) which functions in parallel with an (HA-) relay. There is an (HA-) and an (HB-) relay for each horizontal group.

Due to the chain contacts on the (HA-) relays, the preferred horizontal group (HG) relay

is operated. The (HG-) relay is the connector for the horizontal group, closing through all leads which are necessary for controlling the call from the one horizontal group. Its operation operates the secondary select magnets on all ten secondary switches corresponding to the line links of the horizontal group selected, in preparation for closing the crosspoints later by the operation of the hold magnet.

### VERTICAL GROUP IDENTIFICATION

The vertical group is now chosen by operating all the (V-) relays through the normal contacts of the (H-) relay. As shown on Fig. 2. With a (V-) relay operated, the (TT) relay operates, then when all (V-) relays are operated, the (VT) and the (H-) relays operate. The (H-) relay causes the (V) relays which do not have a locking circuit to release. Only those (V) relays will remain operated which have a call waiting in their respective groups in the particular horizontal chosen. As soon as one of the (V-) relays releases, the vertical selected (VS) relay operates, in turn operating the (VE) relay. The (VE) relay prevents the reoperation of any of (V-) relays which have released, should calls come in from their respective groups, and also operates the (LR) relay associated with the group of ten lines.

### LINE TEST

One front contact of the line relay is then closed through to one of the (LT-) relays and line selection is made as previously described under the end chain relay circuit. The preferred (LT) relay grounds one district preference "DP" lead as shown on Fig. 3, and in addition grounds a class of service "CS" lead.

### DISTRICT GROUP SELECTION

When the (HG) relay operated, leads were closed from the sleeves of the ten line links associated with the selected horizontal group to the test (T) relays as indicated on Fig. 4. All line links which are busy have a ground on their sleeve lead and thereby operate the associated (T) relays at this time. As soon as the trunks tested (TT) relay has operated, a circuit is closed for operating the group (G-) relays through the unoperated (T-) relays indicating idle links. Those (G-) relays will be operated which represent groups having at least two idle district junctions available and which have access to an idle sender link to an idle sender.

### DISTRICT AVAILABLE (FIG. 5)

The sender link grounding the "TA" lead indicates that there are at least two district

## CONNECTING LINE TO SENDER

junctions available in one group of ten. At the completion of connecting a subscriber line to the sender, the (CA) relay in the sender link is operated. The (RA) relay operates if one or more districts in the group of ten are available for handling new calls and the (A) relay operates if two or more districts are idle. The operation of the (A) relay releases the (CA) relay. This closes the "TA" lead through the (CA) and (DP) relays normal and through one or more of the (GB-) relays normal and through the associated secondary switch hold magnets off-normal contacts. The secondary switch hold magnet being normal indicates that there is an idle link between the twenty district junctions and the sender group in question. The (GB) relay being normal indicates that there is at least one sender available in the group of ten senders.

The operation of the line link (G-) relay (Fig. 6) indicates that there is access to an idle sender through an idle line link district junction and sender link. The functional contacts on the (G-) relay operate the line link (D-) relay associated with the selected district junction group. The (D-) relay in operating, being in a chain circuit with other (D-) relays on other line link frames associated with the same group of district junctions which are located on other line link frames, locks out the other line links from this same group of district junctions. The preferred line link (D-) relay then operates the associated (GP-) relay in the sender link (Fig. 6). The operation of the (GP-) relay, through chain contacts, operates a connector group (G-) relay associated with the selected group of districts. This (G) relay closes through all of the leads associated with the group of twenty district junctions which are necessary for completing the call to the sender. The operation of the sender link (G) relay operates the (GE) relay in the line link circuit which in turn releases the line link (G) relays which were not selected, in turn operating the district selected (DS) relay on Fig. 7. The (DF) and (DA) relays associated with the group of districts chosen in the line link are operated, which in turn operate the (BA) relay in the sender link associated with the group of districts chosen. The operation of the line link (DA) relay operates the associated primary select magnet in the line link circuit.

### DISTRICT SELECTION (FIG. 8)

The operation of the (BA) and (DE) relays in the sender link closes through the test leads from the district junctions to the (D-) relay in the sender link circuit. The (DE) relay is operated by the operation of the (RS) relay which operates when the (GP-) relay operates. All (D) relays associated then with idle district junctions in this particular group of ten districts will be operated. The operation of any (D-) relay operates the district selected (DS) relay, in turn releasing the (RS) relay in turn releasing the (DE) relay. All operated (D-) relays lock. One is preferred depending upon which "DP" lead was grounded by the (LT) relays in the line link.

## SENDER GROUP SELECTION

As soon as the sender link (G) relay is operated, the sender link proceeds to select a group of senders in which there are two or more idle senders. In operating the sender group (SG-) relays, it is necessary to have an idle link available from the group of districts already selected to the sender group being chosen, as indicated by the associated secondary hold magnets being normal. The indication that at least two senders are available in the group is shown on Fig. 9 by the "GT" lead. When the (SG-) relays operate, a chain circuit is closed as determined by the preference lead from the operated (GP-) relays to operate the associated (LL) relay. The (LL) relays are in a chain circuit between the various sender link frames indicated on Fig. 10 and are used to give a preference to one sender link for handling a call to a particular group of senders. The preferred (LL) relay then operates the associated sender selected (SS) relay which releases all (SG) relays except the preferred relay. With the (SS) relay operated, and one and only one (SG-) relay operated, the (CC) relay operates, which in turn operates the connector (C) relay which closes through the necessary control leads to the group of senders. The operation of the (C) relay operates the primary select magnet of the sender link frame.

### SENDER SELECTION (FIG. 11)

The (S) relays associated with the idle senders then operate, in turn operating the (P) and (SGE) relays. A particular sender is selected by the operation of the (P) relay, the one preferred depending on which "DP" lead is grounded from the line link. The (SGE) relay operating makes this particular group of senders busy to all other sender link frames during the time that the control circuit is connected to the group of senders. The selected (S) relay operates the sender link secondary selecting magnet associated with the chosen sender and grounds the sender control "SC" lead to the sender.

### OPERATION OF HOLD MAGNETS

The operation of the primary and secondary sender link select magnets operates the operate hold (OH) relay and in turn the (GH) relay, as shown on Fig. 12. The operation of the (OH) and (GH) relays in conjunction with the selected (D) relay operate the primary sender link hold magnet associated with the selected district and also the secondary line link hold magnet Fig. 7 associated with the selected district. The operation of the secondary line link hold magnet operates the (T) relay Fig. 13 associated with the selected line link which in turn operates the primary or subscriber line hold magnet. The (T) relay is operated at this particular time in order to check that the relay and its connection to the line link is workable, since had there been an open contact at the time the line links were tested, the (T) relay would have non-operated the same as if the line link were idle. The operation of the line link

primary hold magnet Fig. 14 releases the line relay which in turn releases the (RE) relay. The release of the (RE) relay connects ground to the "ON" lead to the sender circuit as an indication that the line has been seized. The line link primary and secondary hold magnets are held over the sleeve lead through the district junctor to ground on the off-normal contacts of the primary hold magnet in the sender link.

#### DOUBLE CONNECTION TEST (FIGS. 12 AND 15)

The operation of the primary sender link hold magnet operates the secondary sender link hold magnets which closes its operating ground over the "S" lead to the sender and back over the "SL" lead to the sender link operating the (SL) relay as an indication that the sender has been seized. The operation of the (SL) relay releases the (OH) relay which in turn effectively places the winding of the double connection (DC) relay in the holding circuit of the sender link primary and secondary hold magnets in order to determine if a double connection has been made in the sender link. If there is no double connection, the (DC) relay operates, in turn operating the (DR) relay in the sender link, then awaits a disconnect signal from the sender.

#### REGISTRATION OF CLASS OF SERVICE

When the sender link selects an idle sender grounding the "SC" lead, the (SC1) and (SC2) relays in the sender operate. The operation of the (SC1) relay closes through the "S" lead to the "SL" lead, the frame indication leads "FOO" and "F10" and also the class of service leads to relay in the sender. There will always be two "CS" leads grounded on each call. One of the leads "CS0" to "CS5" will be grounded by the operation of the (LT) relay as previously mentioned (see Fig. 16). The "CS6" or "CS7" lead will be grounded from the (DF) relay associated with the selected group of districts. These leads are closed through the sender link and operate the corresponding relays in the sender circuit which lock to an off-normal ground.

#### DISTRICT FRAME REGISTRATION

The (SC2) relay closes through the ten "FO" to "F9" leads (see Fig. 17) to the select magnets of the sender crossbar switch, the "FO" lead connecting to the (0) select magnet and the "F9" lead connecting to the (9) select magnet. Only one of these "F-" leads is grounded and when the corresponding select magnet operates, it operates the (SM1) relay as shown on Fig. 17. The (SM1) relay locks the operated select magnet and operates the (SM2) relay. The (SM2) relay operates the (SM3) relay which closes an operating circuit

to the (F) hold magnet through one winding of the (SM2) relay and operates the register advance (RA2) relay. The operation of the (SM3) relay releases the (SM1) relay which opens the operating circuit to the (SM3) relay. The (SM3) and the select magnet are now locked to a front contact on the (SM2) relay. The (SM2) relay does not release until the (F) hold magnet is operated. When the (F) hold magnet operates, it locks to off-normal ground and short-circuits the (SM2) relay, causing it to release. The release of the (SM2) relay in turn releases the select magnet and the (SM3) relay. The release of the (SM3) relay permits the (RA3) relay to operate, which in turn operates the (RA4) relay.

#### DIAL TONE

The operation of the (RA4) relay closes ground from the released (RE) relay in the line link circuit over the "ON" lead to operate the (ON1) relay in the sender as shown on Fig. 18. The operation of the (ON1) relay connects the (L) relay from battery to the ring lead and the dial tone coil from ground to the tip lead. With closure of the tip and ring at the subscriber station, the (L) relay operates in turn, operating the (SR) relay to connect dial tone to the subscriber.

#### DISCONNECTING CONTROL CIRCUITS OF LINE LINK AND SENDER LINK

The operation of the sender (ON1) relay grounds the "SB" lead to operate the associated (SB) relay in the sender link circuit, as shown on Fig. 19. This provides a sender busy condition to all other calls as long as the sender is held. The operation of the (SB) relay operates the sender (ON2) relay under control of the (DR) relay in the sender link. As previously stated, the (DR) relay indicates that the primary and secondary crosspoints in the sender link have been closed through. The operation of the (ON2) relay locks the (ON1) relay and itself under control of the sender (AV4) relay. The operated (ON2) relay also places ground on the sleeve lead to hold the sender link connection as long as the sender is required in establishing the call. The (ON2) relay in addition grounds the release "RL" lead back to the sender link and controller circuit, operating the (AB) relay. The operation of the sender link (AB) relay operates a release (RL) relay in the sender link, in turn operating the release (RL) relay in the link link, thereby causing the control circuits in the sender link and the line link to restore to normal. The connection is then established from a calling subscriber through a district junctor to a subscriber sender and the controller circuits of the line link and sender link frames are available to handle another call.

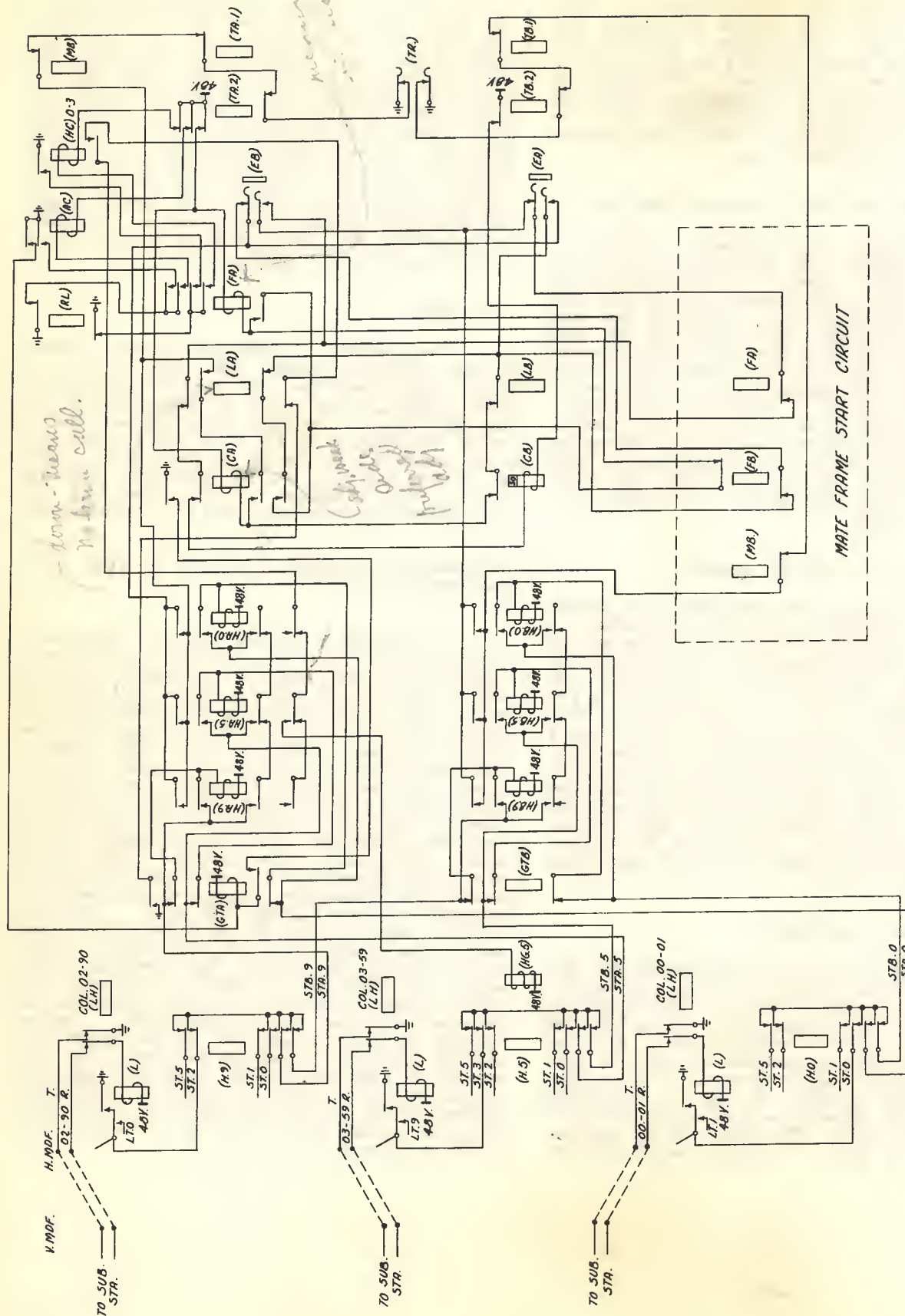


Fig. 1 - Line Link Group and Control - Start and Horizontal Group Selection

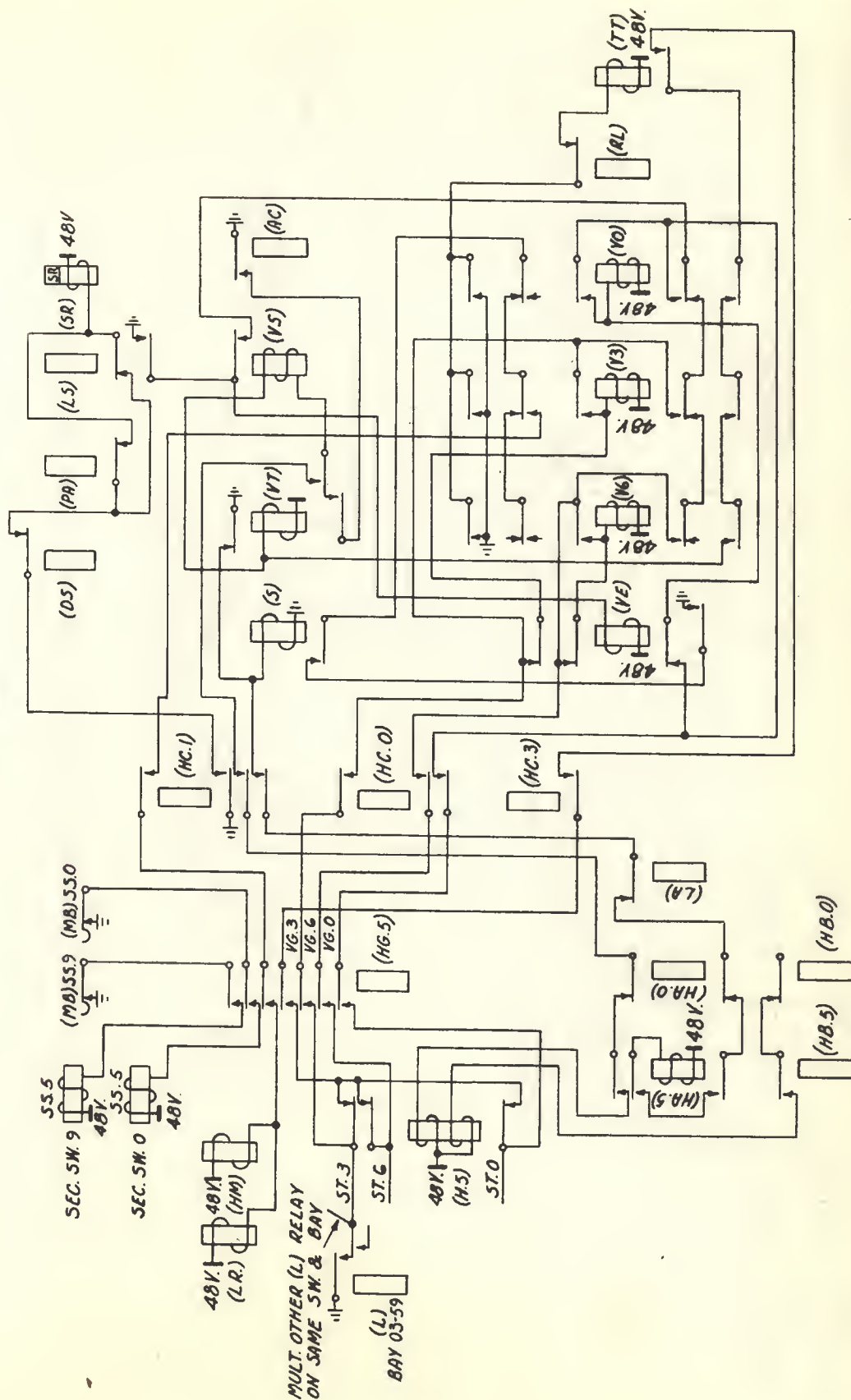


Fig. 2 - Line Link Group and Control - Vertical Group Selection

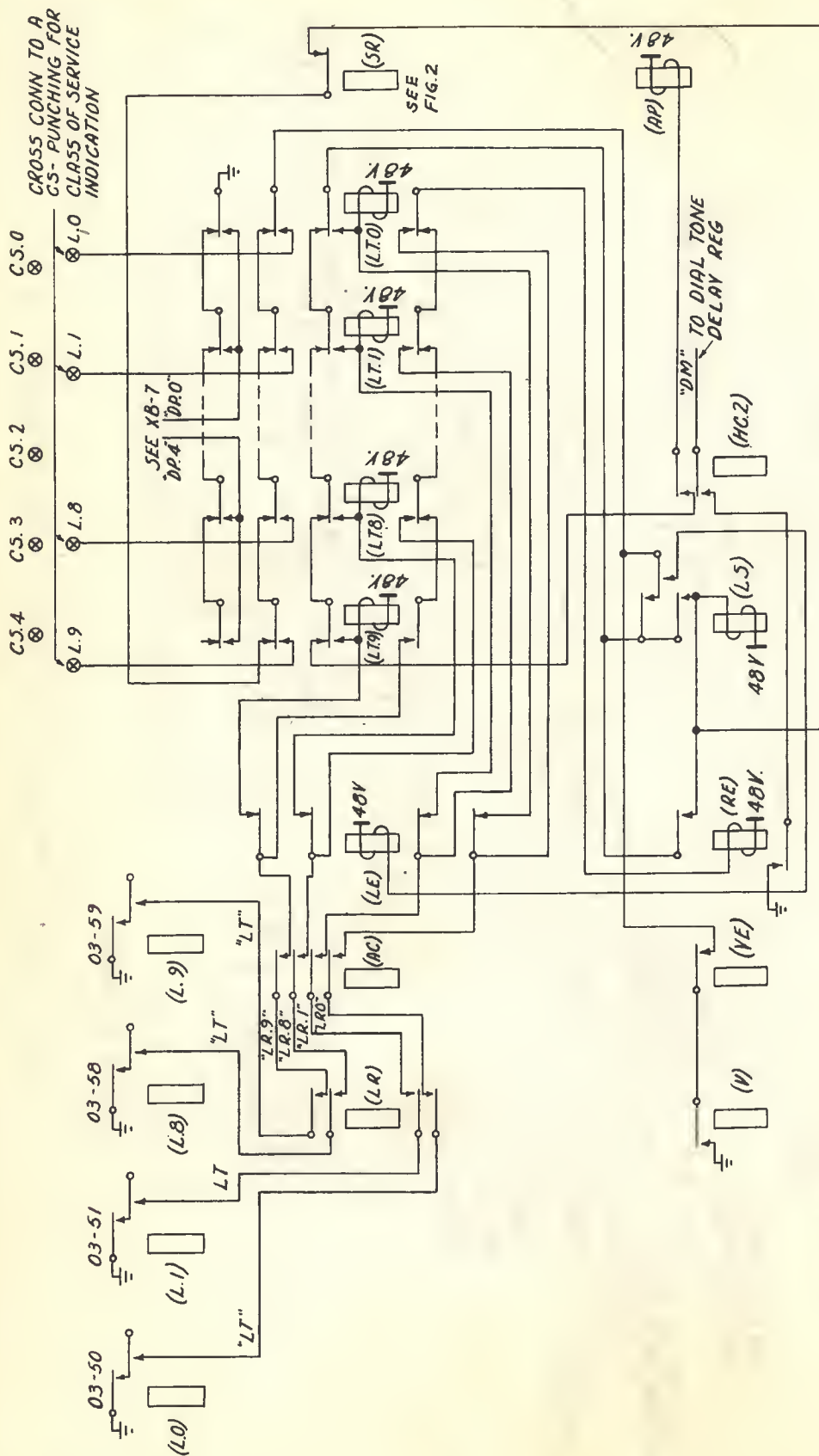


Fig. 3 - Line Link Group and Control - Line Selection and Identification

*SUB. SENDER LINK & CONTROL*

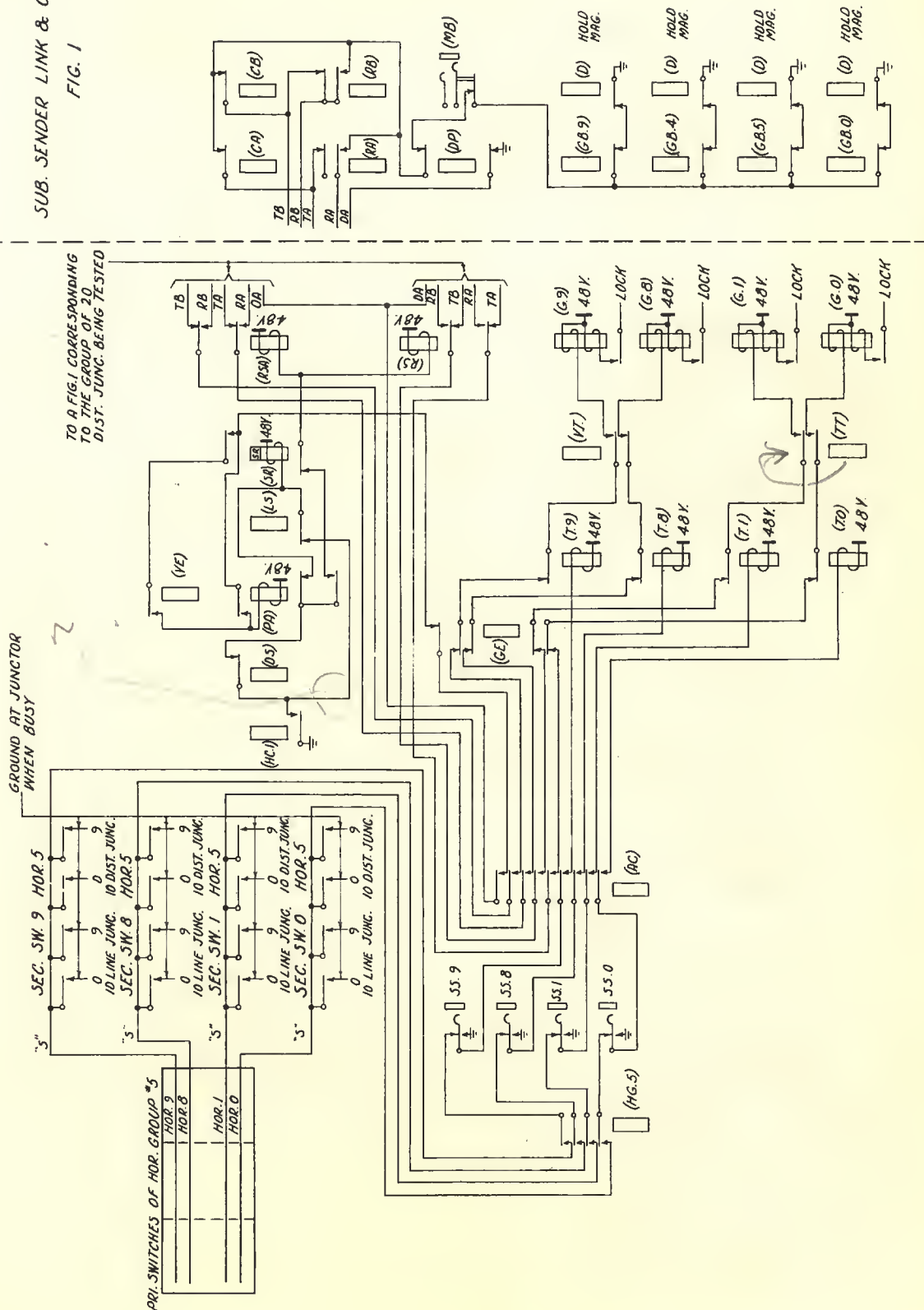


Fig. 4 - Line Link Group and Control - District Junctor Group Test, Regular and Reserve

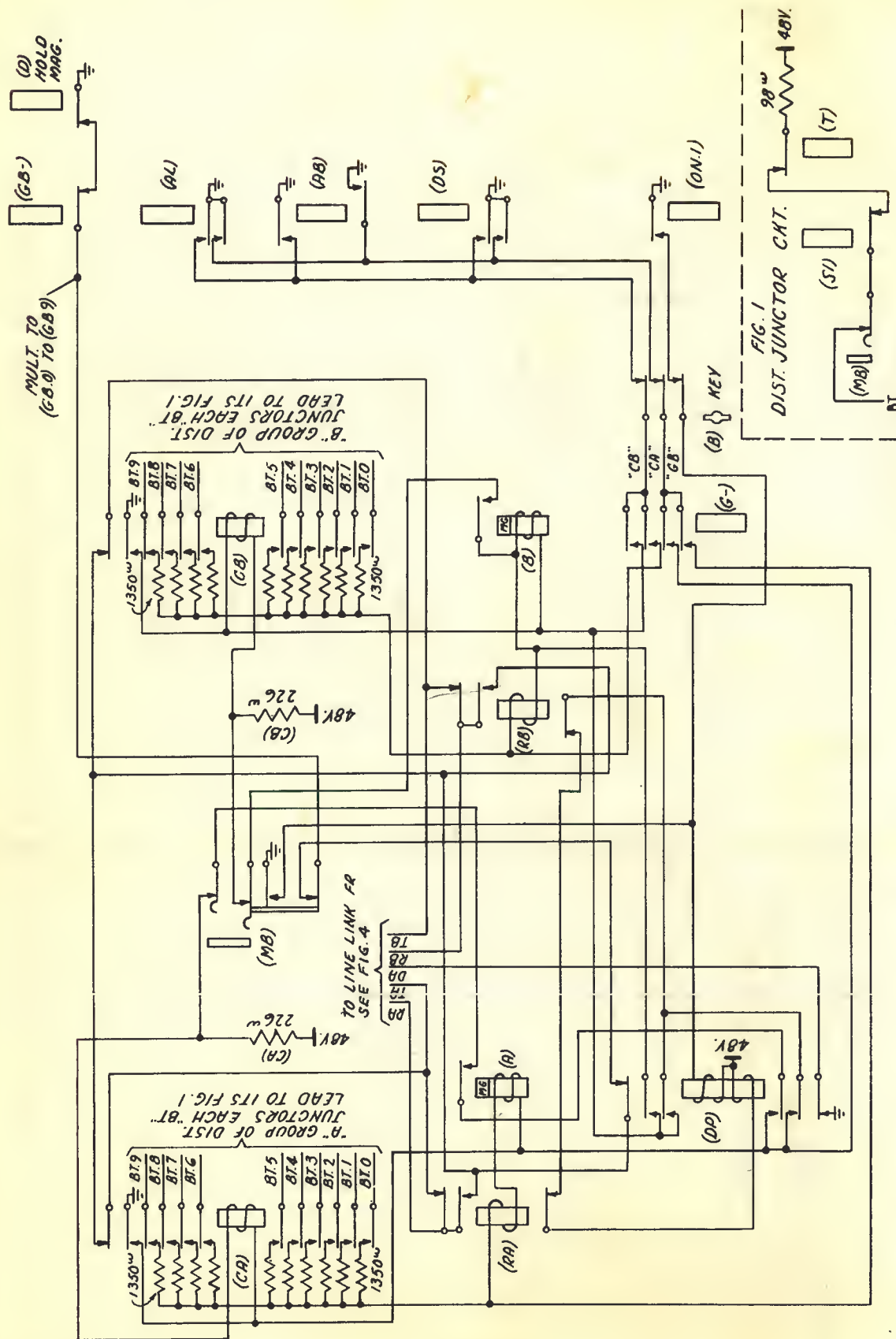


Fig. 5 - Subscriber Sender Link and Control - District Group Indication Toward the Line - Line Link and Group Control Circuits

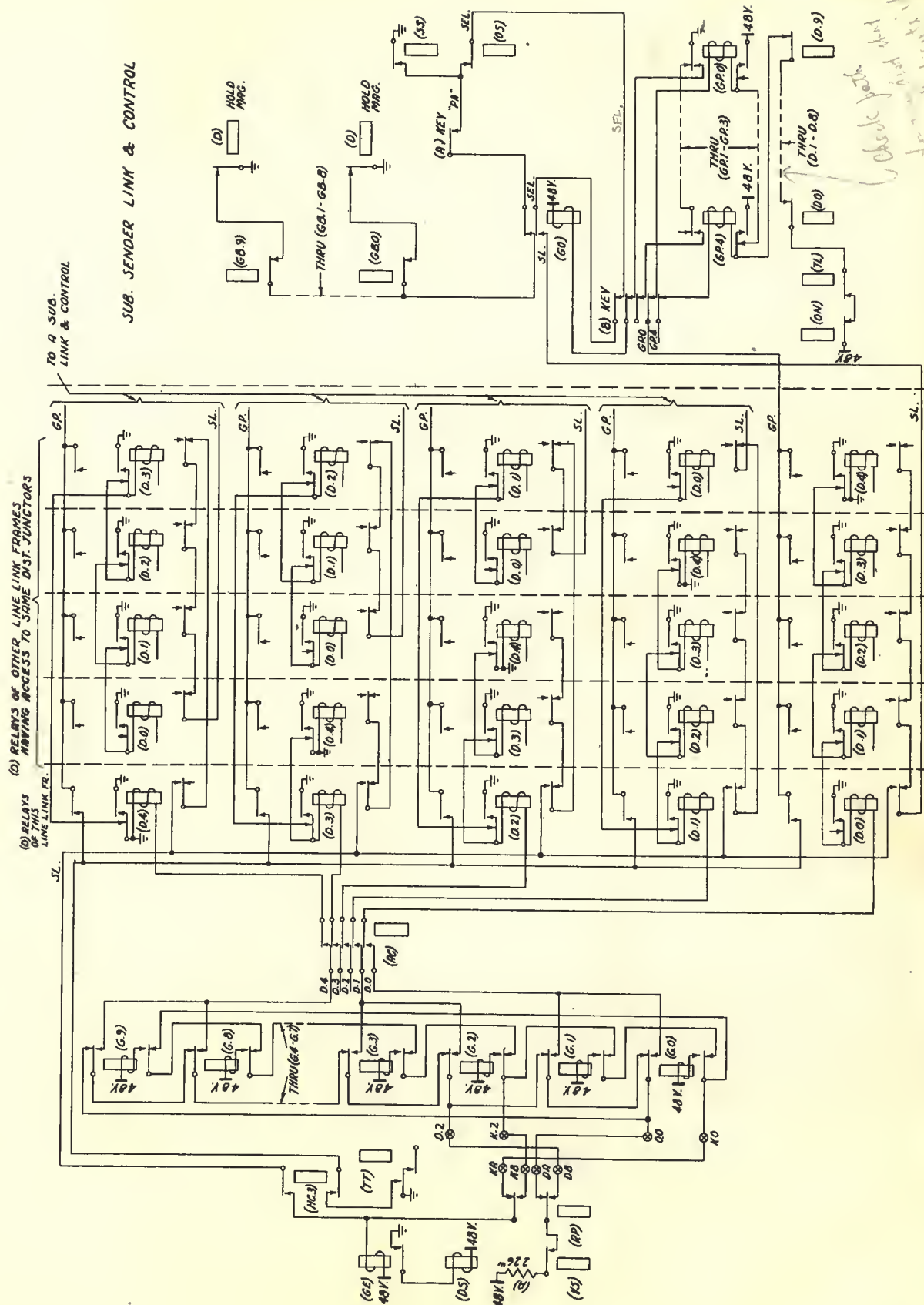


Fig. 6 - Line Link Group and Control - Selecting a Group of Twenty District Junctions and Starting the Sender Link and Control Circuit

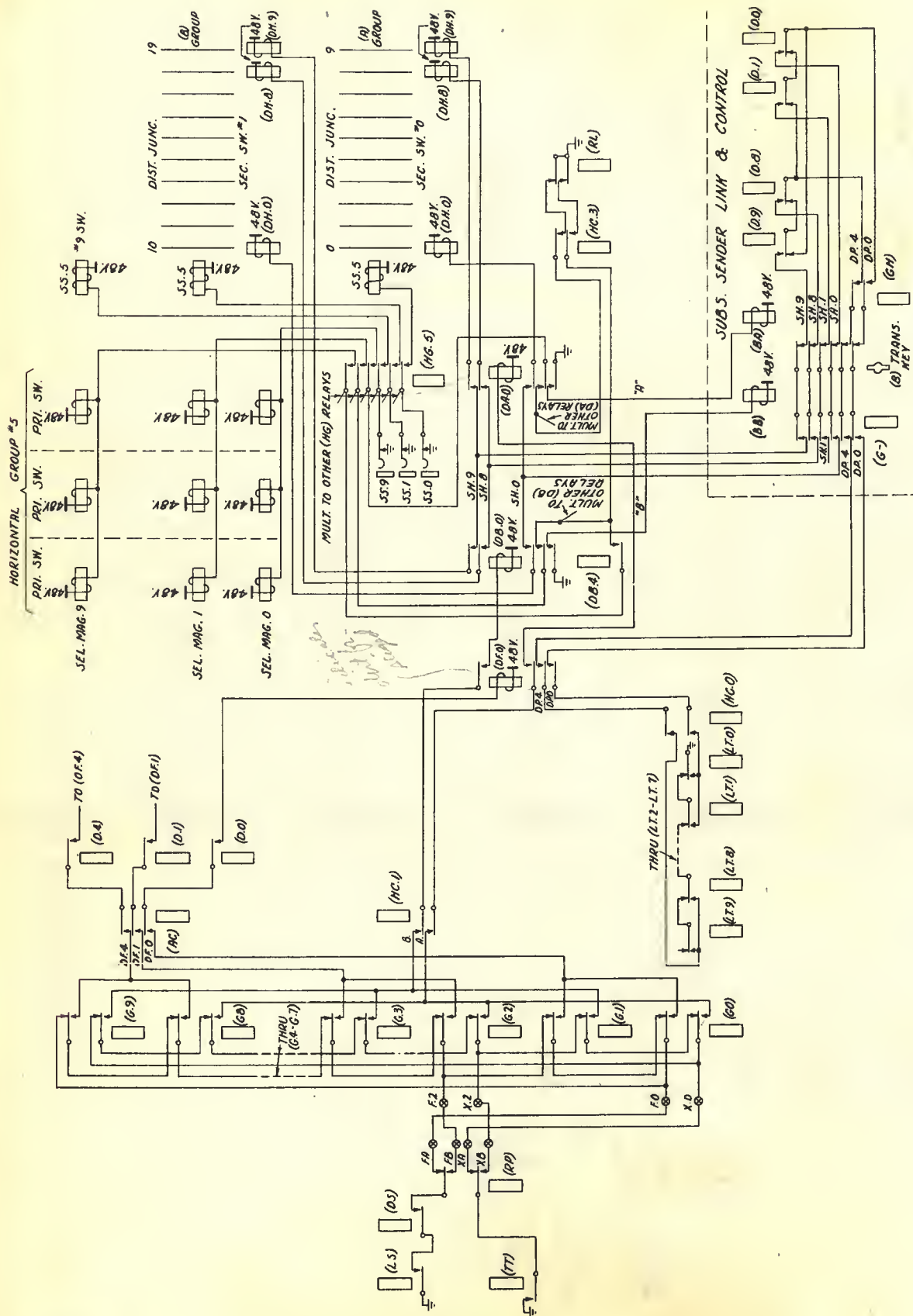


Fig. 7 - Line Link Group and Control-District Junctor Selection

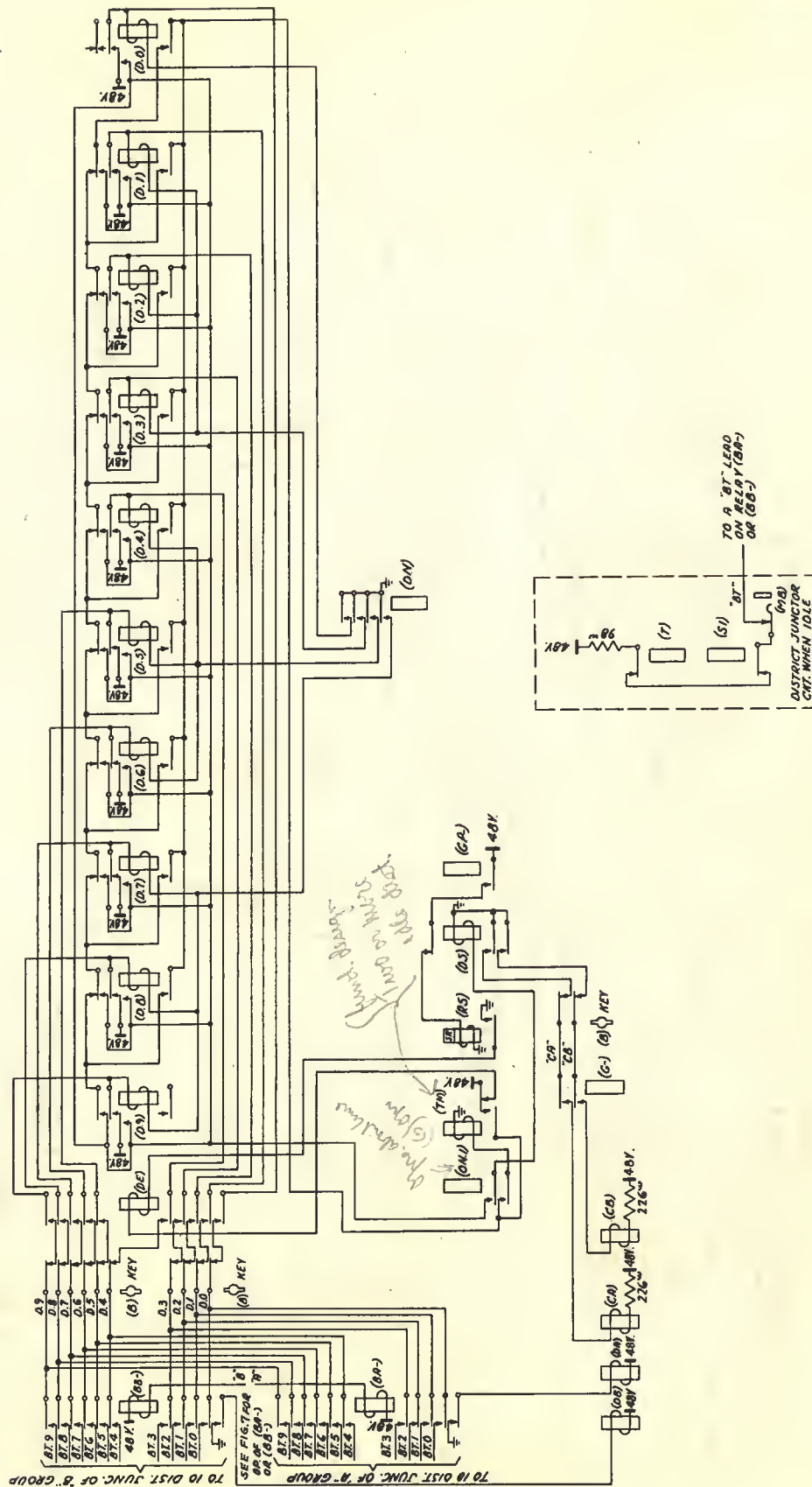


Fig. 8 - Subscriber Sender Link and Control - Indicating Which District Junctors are Idle in Selected Group of Ten

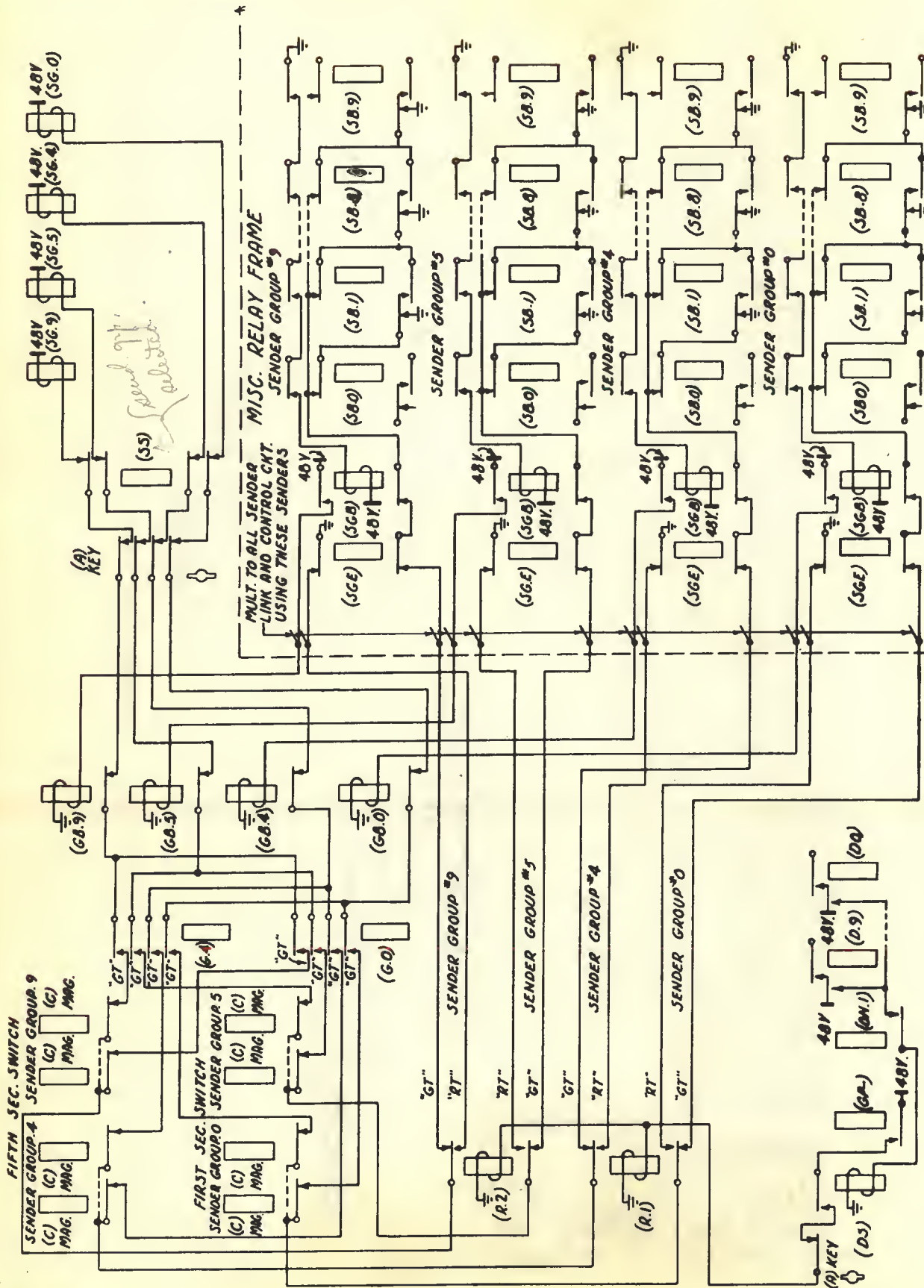


Fig. 9 - Subscriber Sender Link and Control - Regular and Reserve Sender Group Test

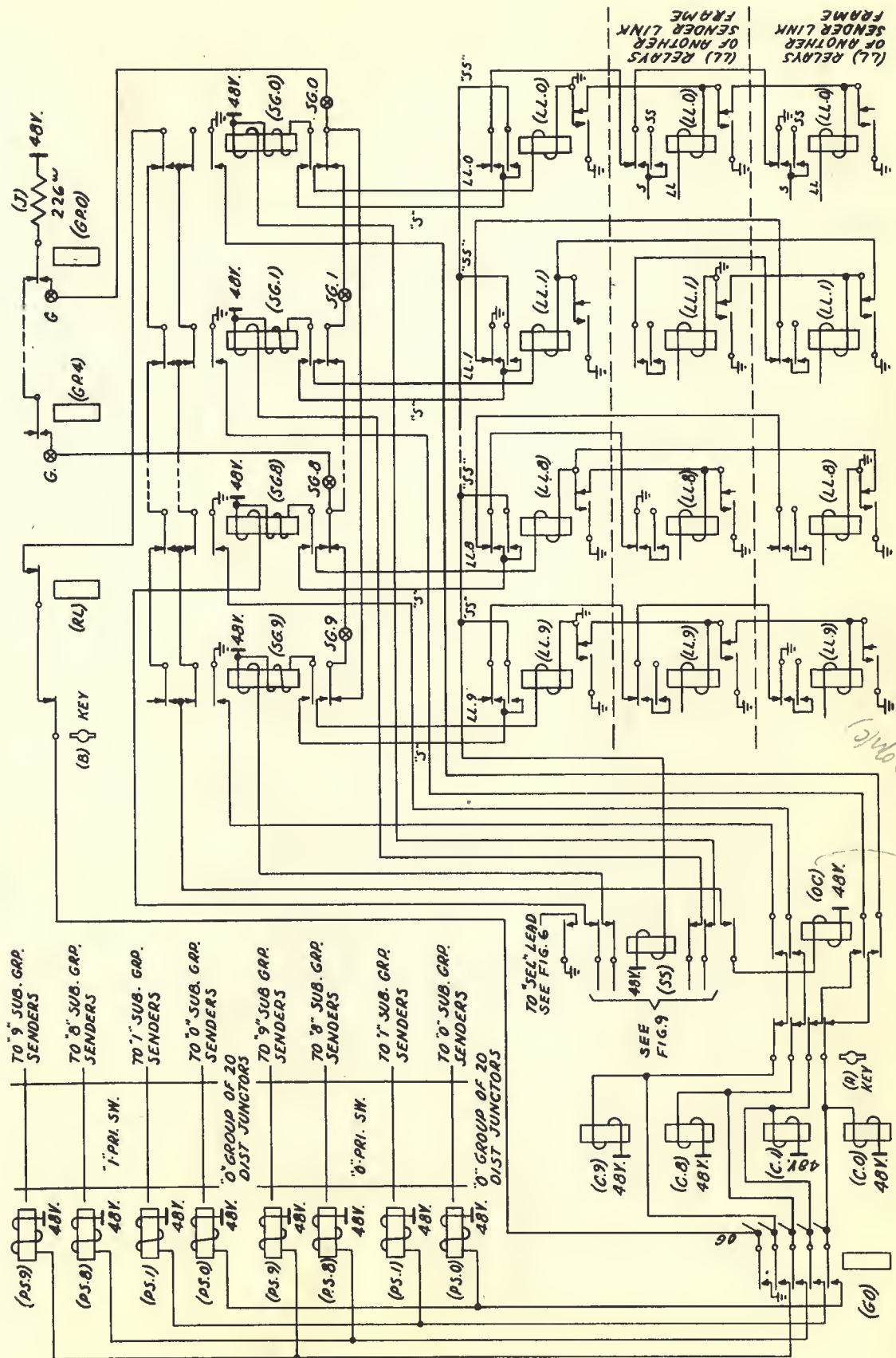


Fig. 10 - Subscriber Sender Link and Control - Sender Group Selection

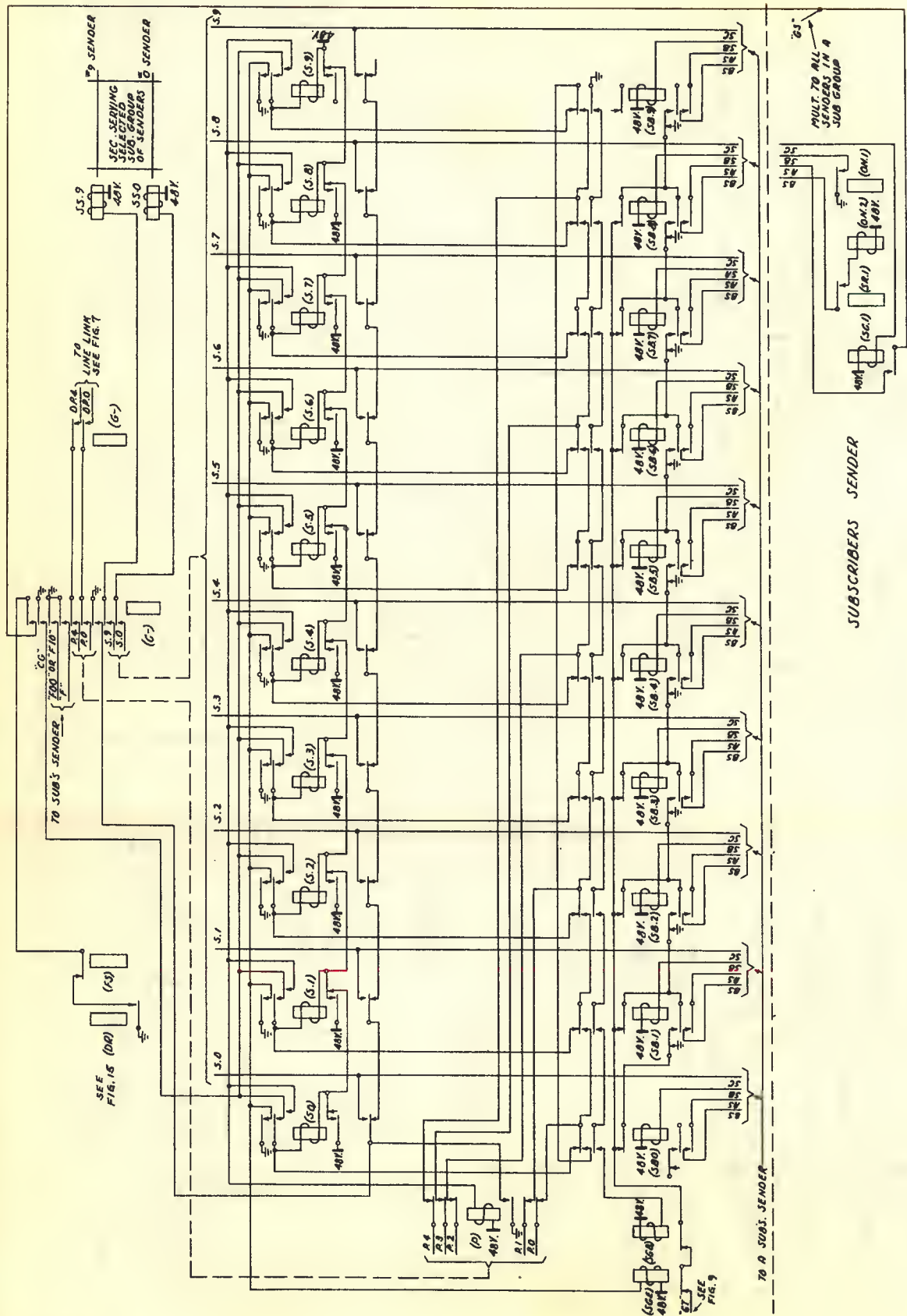


Fig. 11 - Subscriber Sender Link and Control - Sender Selection

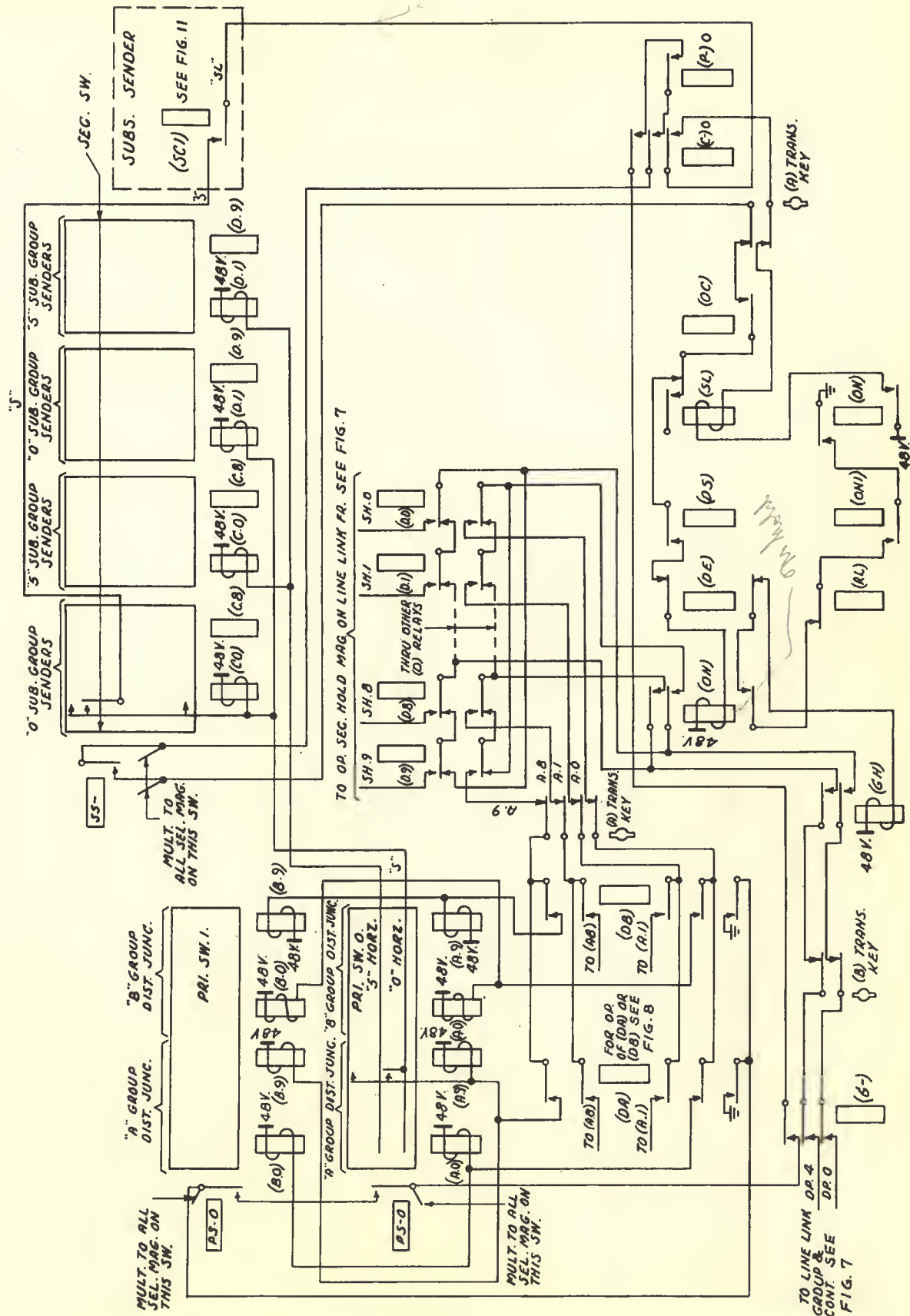


Fig. 12 - Subscriber Sender Link and Control - Operation of Primary and Secondary Holding Magnets and Also (SL) Relay

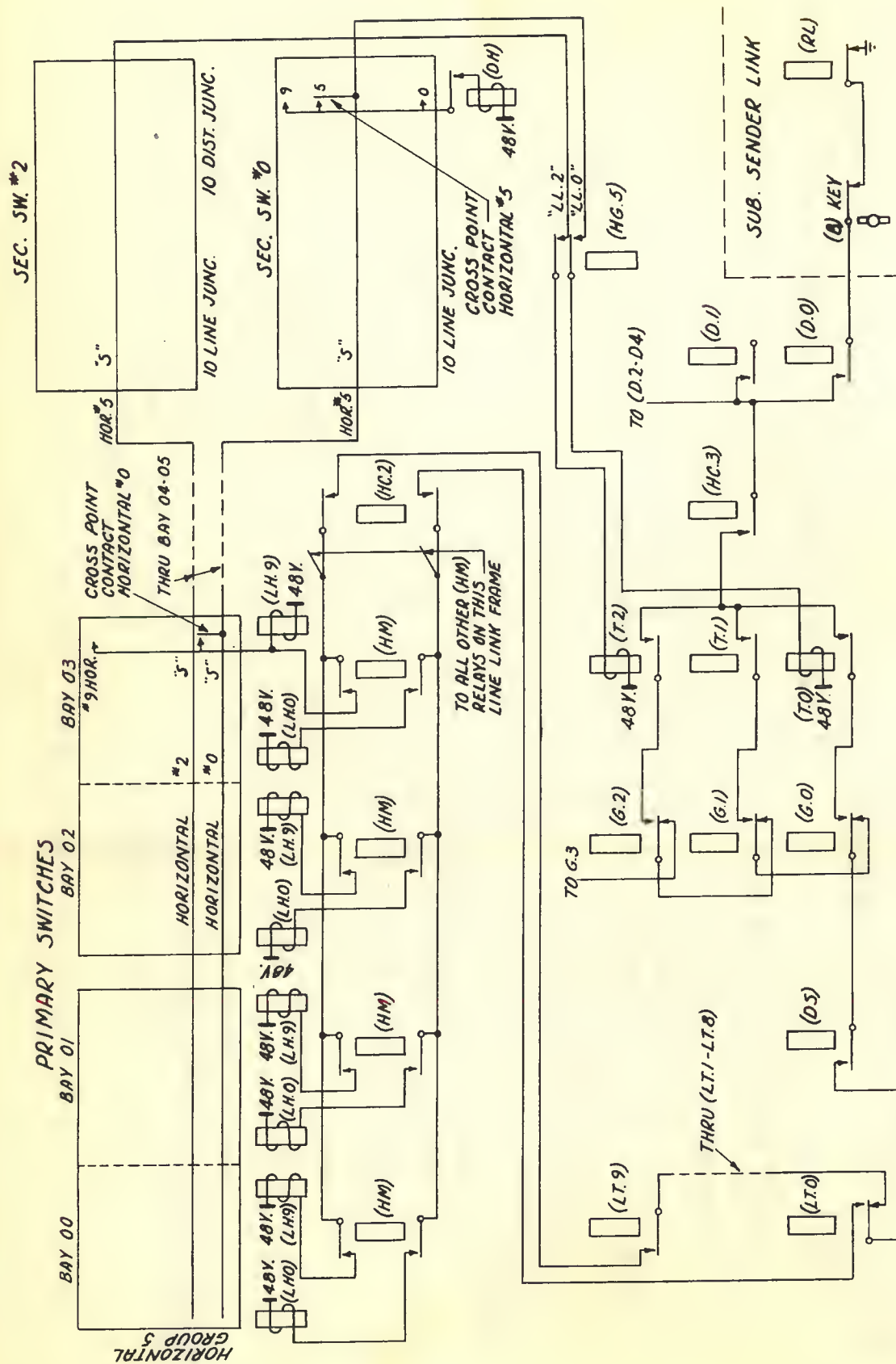


Fig. 13 - Line Link Group and Control - Operation of Line Hold Magnet

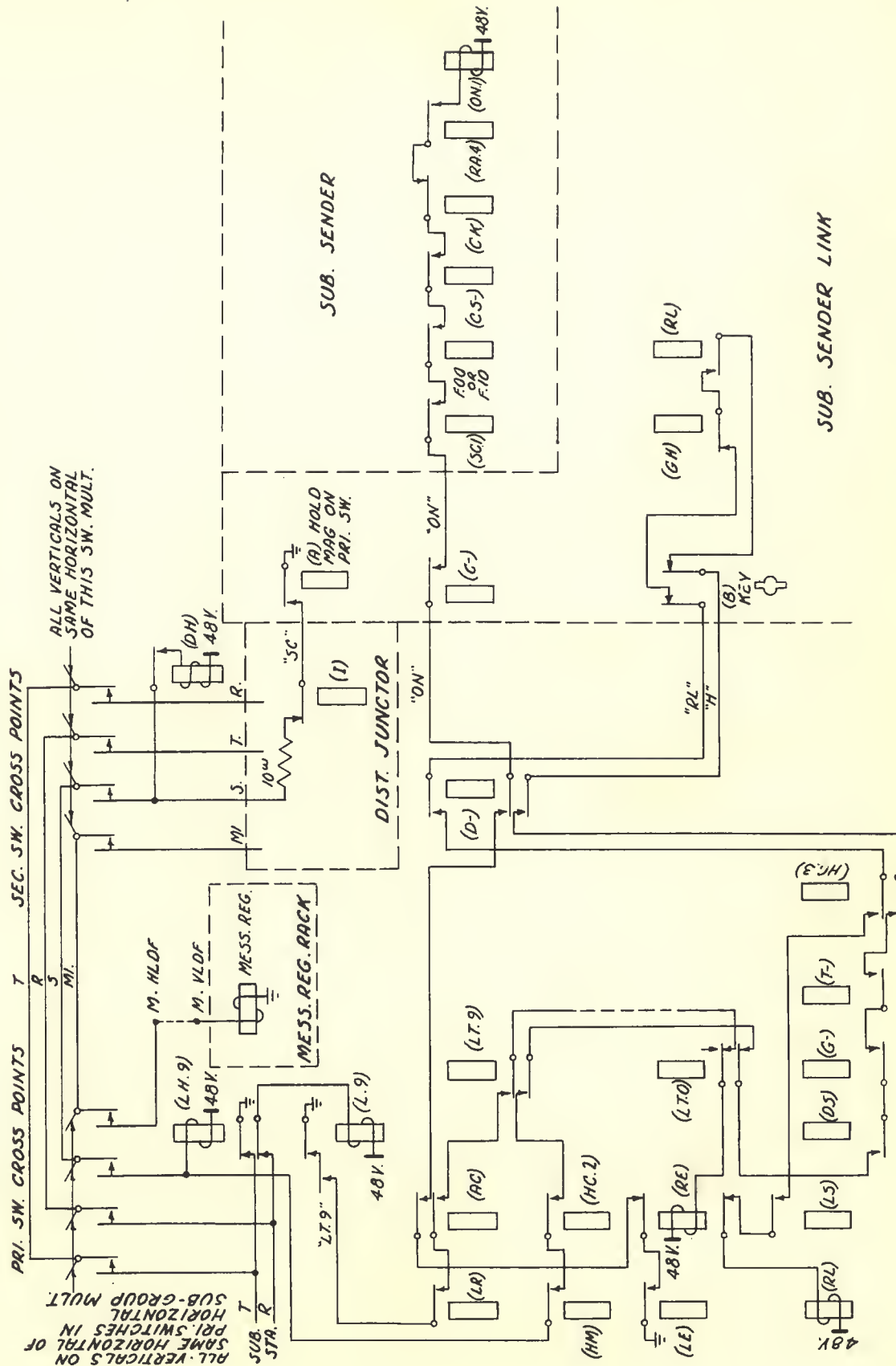


Fig. 14 - Line Link Group and Control - Indication of Sender That Primary and Secondary Hold Magnets Have Operated and Operation of Line Link (RL) Relay

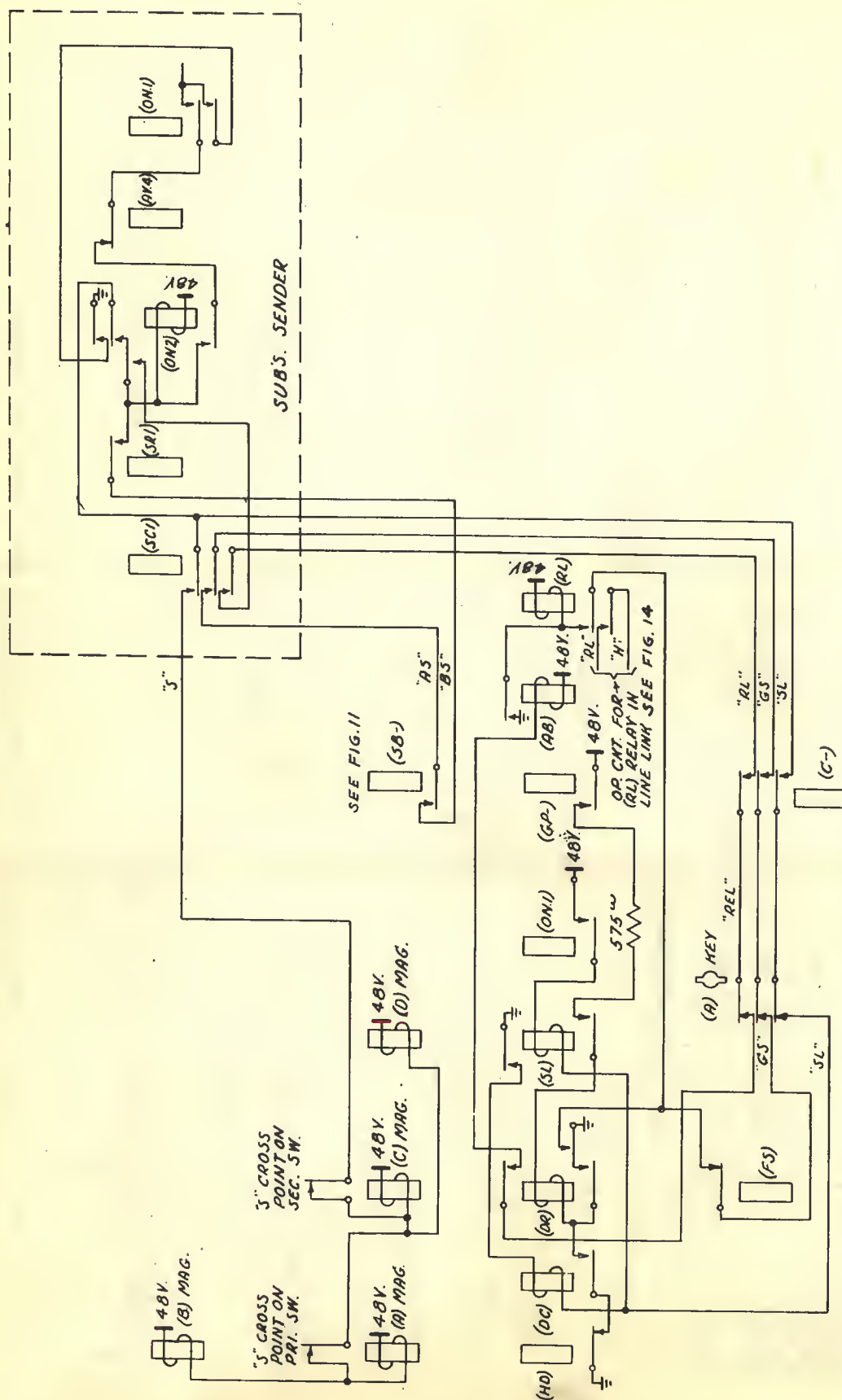


Fig. 15 - Subscriber Sender Link and Control - Double Connection Test, Hold of Primary and Secondary Holding Magnets and Operation of (RL) Relay

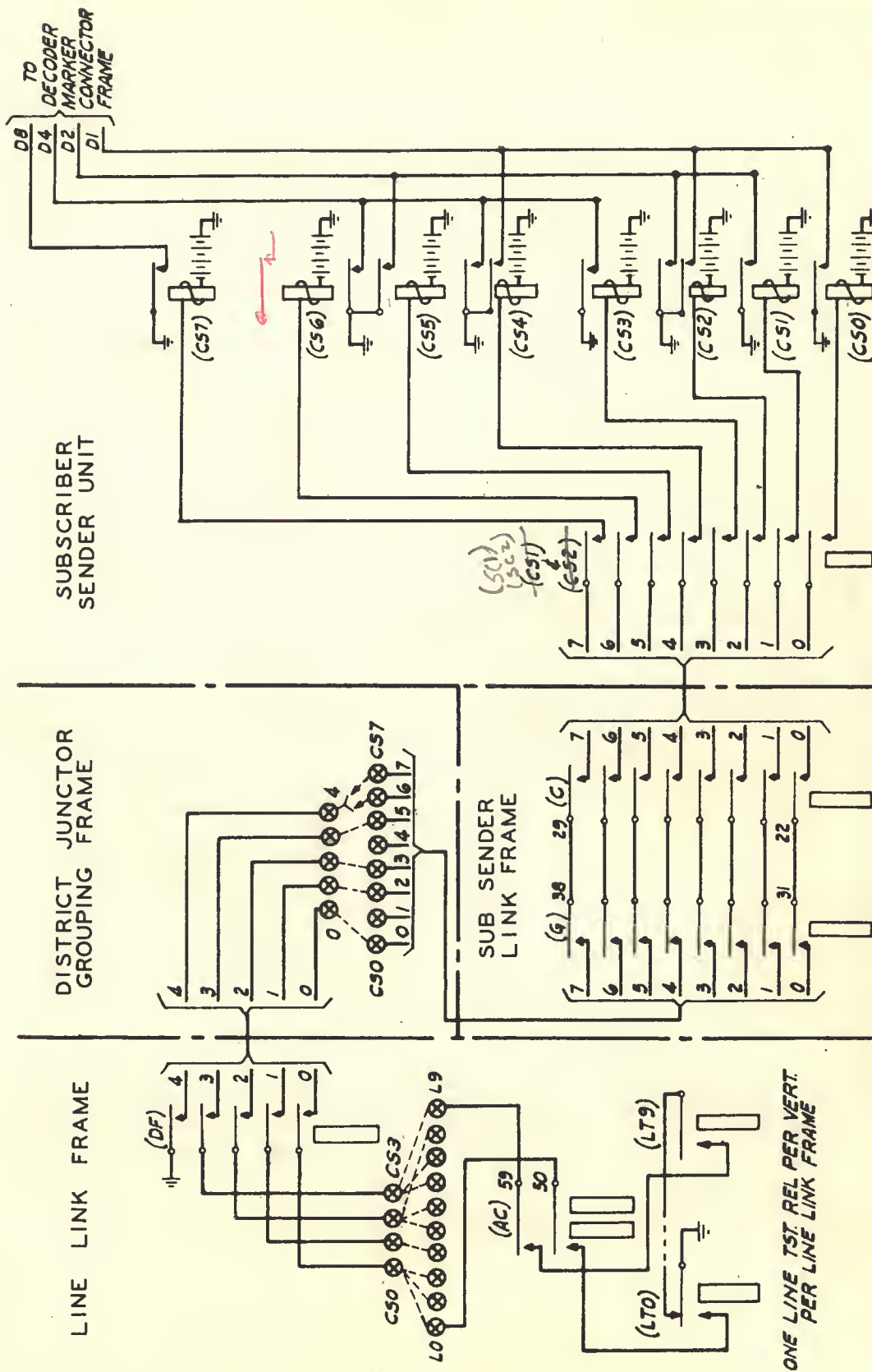


Fig. 16 - Subscriber Class of Service Registration - Crossbar Office

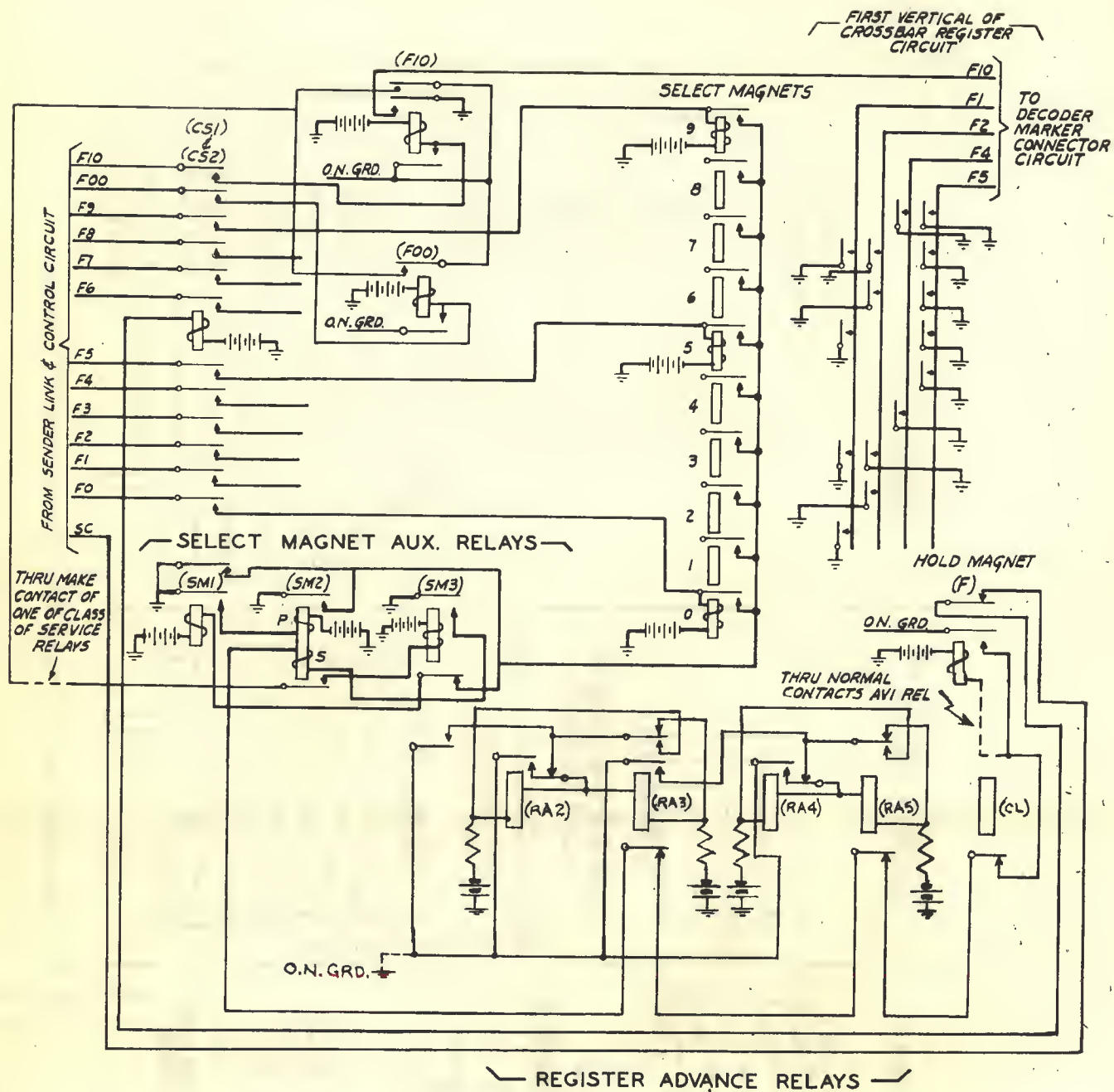


Fig. 17 - District Frame Registration Crossbar Subscriber Sender

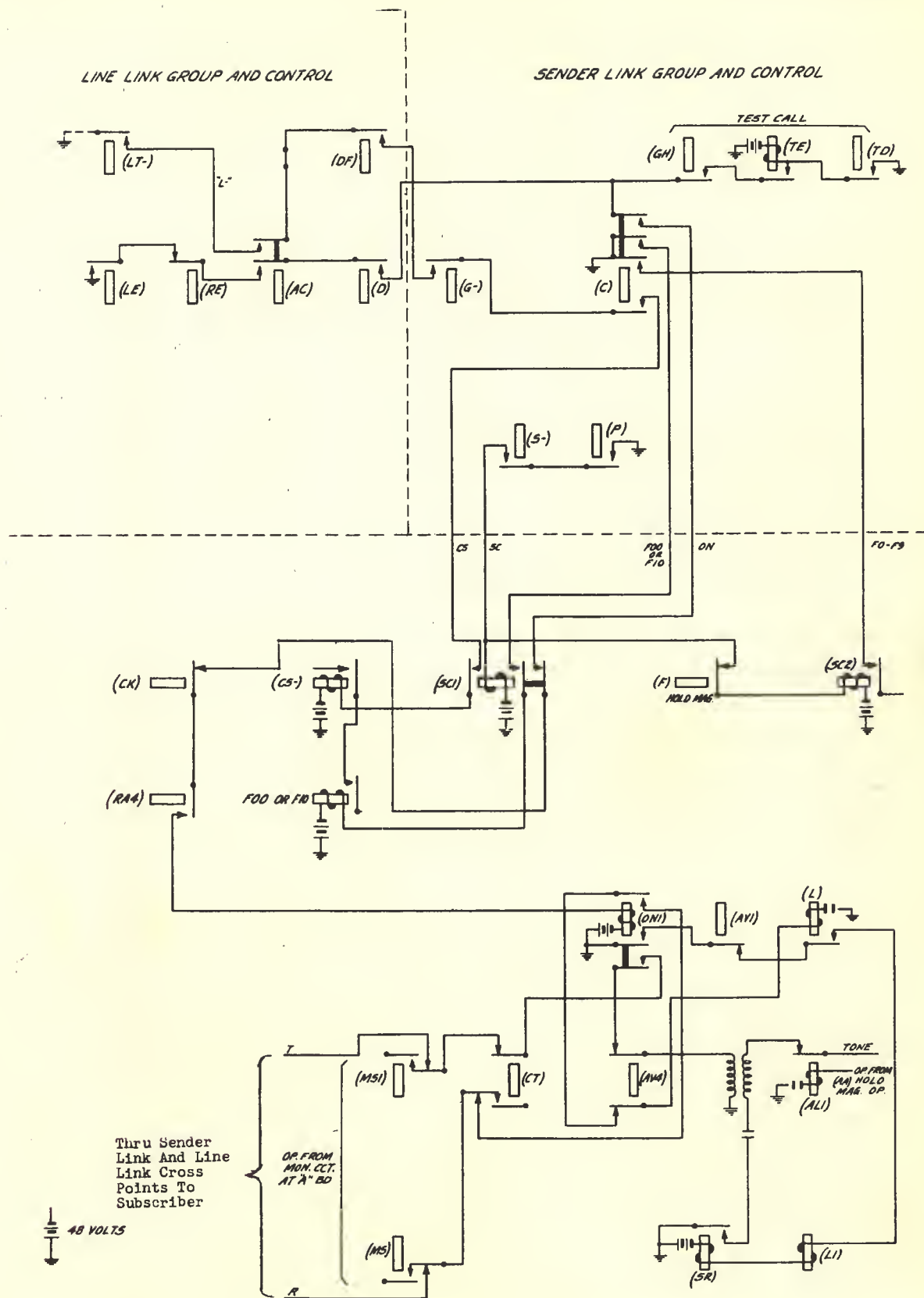
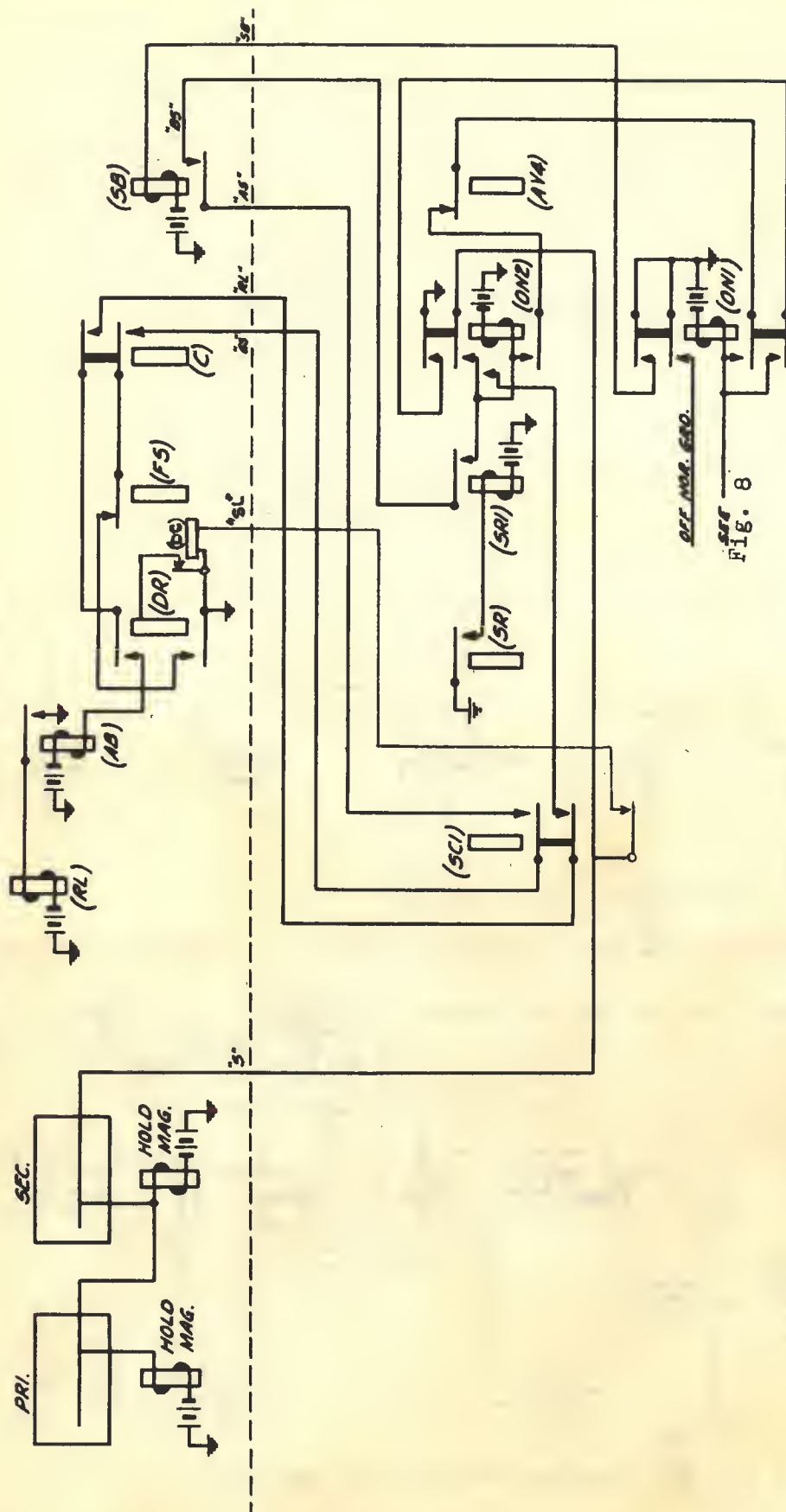


Fig. 18 - Subscriber Sender Receiving Dial Tone

## SENDER LINK AND CONTROL CIRCUIT



OPERATING RELAY (ON2) AND LOCKING (ON1) AND (ON2) RELAYS UNDER CONTROL OF (AV4) ALSO PLACING GROUND ON SLEEVE TO HOLD PRI. AND SEC. HOLD MAGNETS UNTIL RELAY (AV4) OPERATES

Fig. 19 - Subscriber Sender Holding Sender Link Hold Magnets and Release of Control Circuit

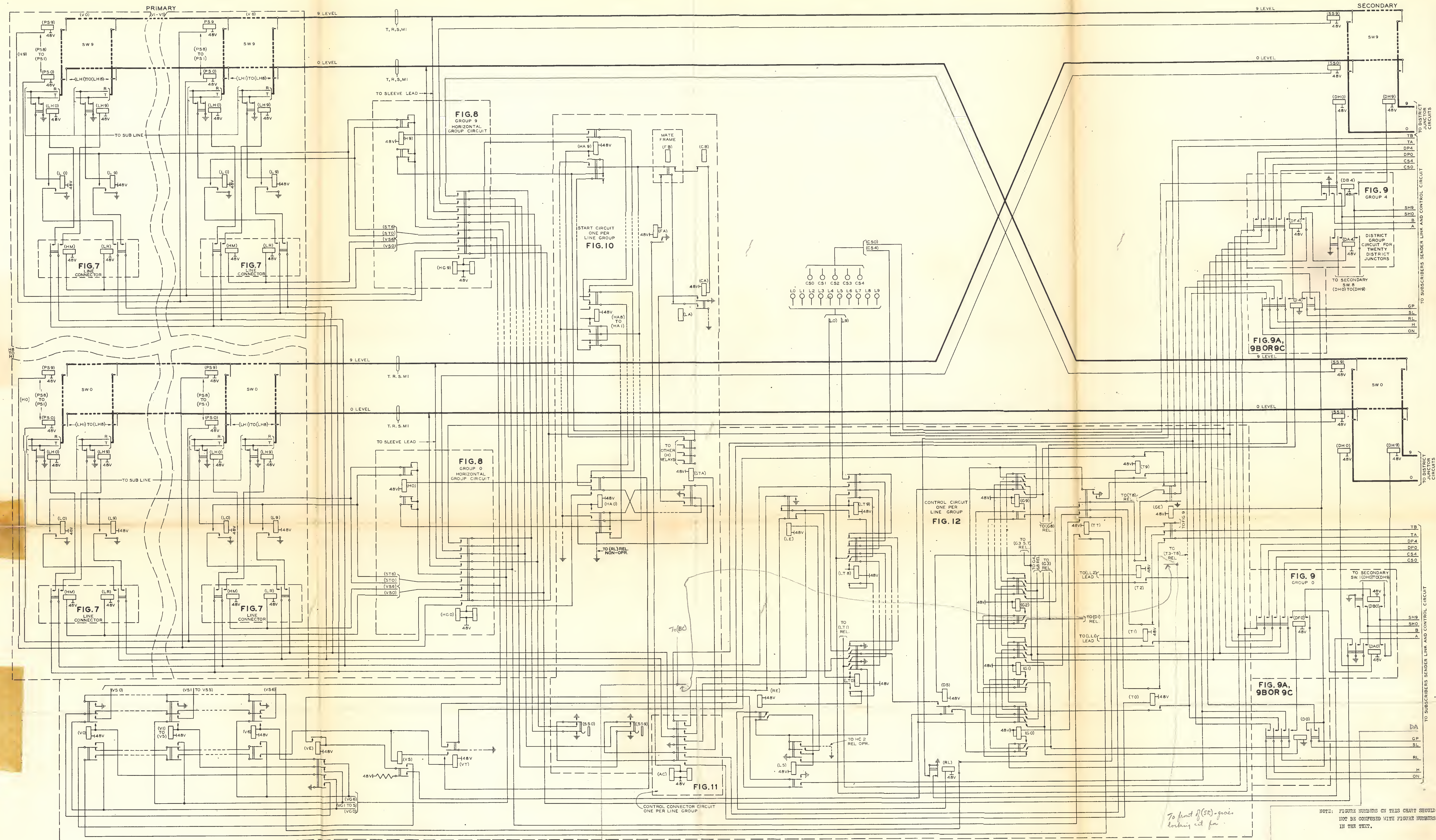


Fig. 20 Subscriber Line, Line Link, and Group Control Circuit



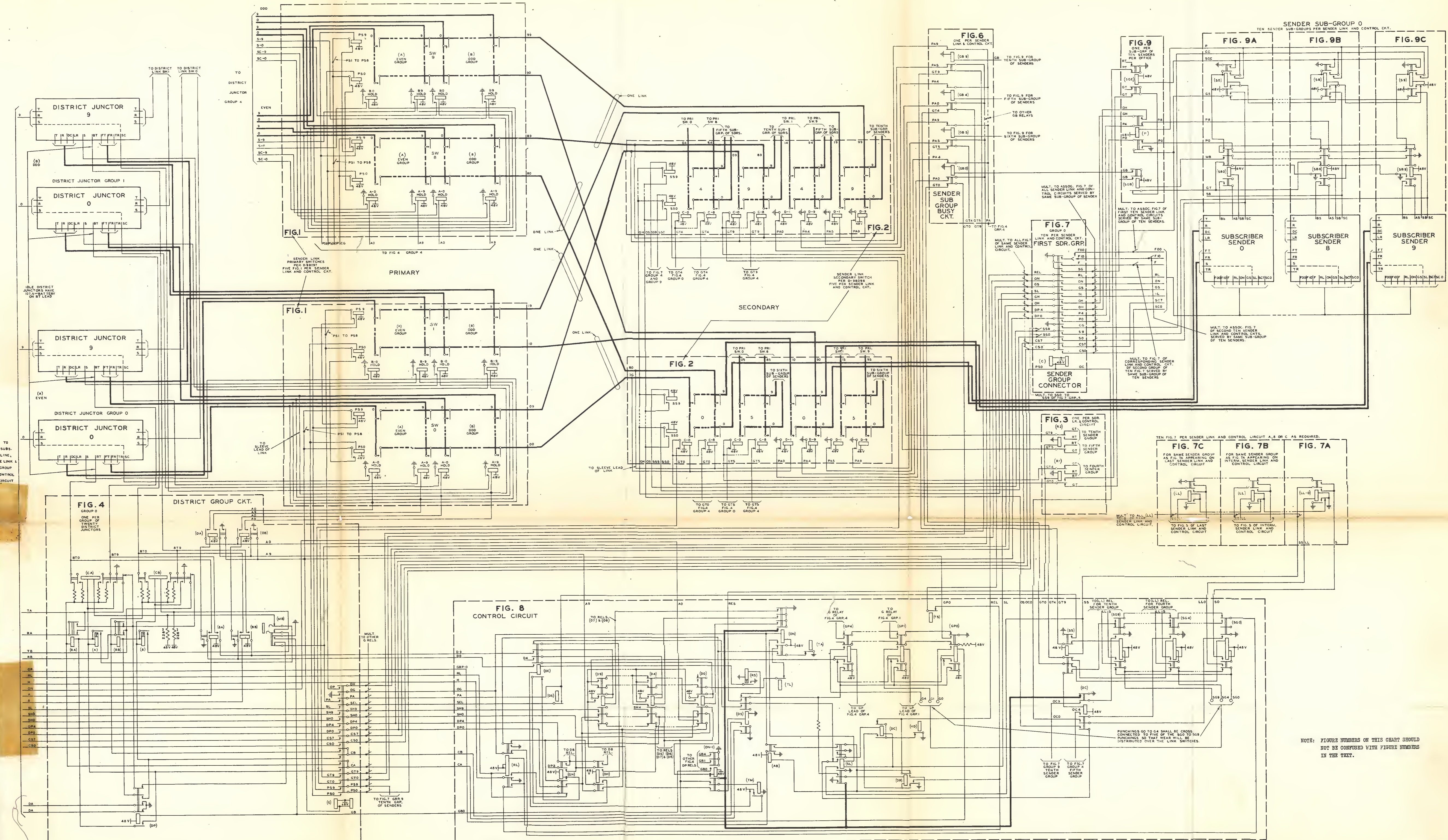


Fig. 21 - Subscriber Sender Link and Control Circuit



## CHAPTER 15 - REGISTRATION OF CALLED NUMBER

### DIALING AND PULSE COUNTING

The dialing circuit used in the subscriber sender is shown on Fig. 1. The polarized line (L) relay operates when the "T" and "R" leads are cut through from the called subscriber line to it and the tone repeating coil. The (L) relay remains operated except for a momentary release on each break of the dial until the sender is disconnected unless the subscriber previously hangs up to abandon the call. Its secondary winding which is in series with a condenser provides a circuit for locking the relay operated for a short period of time (the time required for the condenser to charge) thus amplifying short front contact closures and short back contact openings which otherwise might be too short for properly actuating the (SR) and (L5) relays. This feature has a further beneficial effect upon the release of the relay in that it locks it in the released position for a short period of time thus enabling it to withstand an impulse to reoperate falsely during the dial open interval due to transient currents through the substation ringing bridge and the primary winding of the (L) relay. The tertiary winding of the (L) biases the relay taking the place of the retractile spring normally used for this purpose. The use of this winding, combined with a neutral adjustment, gives the relay a comparatively high "percentage release" which makes it possible for the relay to respond to closed periods of the dial even though the operating current in the line at such times is only slightly higher than the release current existing during open periods of the dial.

The 4 mf condenser in series with 600 ohms resistance connected between the ring and ground prevents the false release of the (L) when retard coil holding bridges are inserted into the loop by various circuits such as PBX dial circuits.

The slow release (SR) relay and its auxiliary (SR1) relay operate on the first operation of the (L) relay and release when the call is completed or abandoned. They hold up continuously regardless of the momentary releases of the (L) relay due to dial pulses. These relays then have a marginal time condition to meet holding over dial pulses but releasing when the subscriber abandons the call in as short a time as is consistent with holding over dial pulses. The maximum release time of the (SR) relays is held to a minimum value in order to free the subscriber line as soon as possible when the subscriber abandons a call, especially when he realizes he has made a mistake in dialing and expects to start a new call immediately.

The (L1) and (L2) relays operate and release with the (L) relay. The (L1) relay merely provides additional contacts for the (L) relay. The (L2) relay is fast release and somewhat slow op-

erating and serves to supply locking ground on the (L3) relay while the (RA) is operating on the first pulse.

The register advance (RA) relay operates through the back contact of the (L1) relay on the first dial break of each digit dialed and remains operated throughout the string of pulses of the digit. The (RA) relay releases when the dial comes to rest after each digit, since additional time is allowed between the pulses of two successive digits. The (RA) relay is slow release to hold over dial pulses; however, it must release between digits. Very little time is allowed between digits by some subscribers and especially some PBX operators. The (RA1) relay is operated while the (RA) relay is normal, to provide additional contacts. These relays are used in advancing the registration equipment from the storing of one digit to the storing of the next digit.

The (L3), (L4), and (L5) relays in combination with relays (P1) to (P6) form an economical type of pulse counting circuit in which a total of only nine relays serve to record ten pulses. The first three relays form a "WZ" combination which responds to the relatively short openings and closures of the (L) relay back contact and change these into output closures to the (P-) relays whose duration is that of one full dial pulse cycle. The (L3) relay operates when the (L) relay releases on the first dial break of each digit. The (L5) relay operates over its primary winding in series with the (L3) relay when the (L) relay operates on the next dial closure. The (L4) relay operates in series with the secondary winding of the (L5) relay when the (L) relay releases on the second dial break. The operation of the (L4) relay releases the (L3) relay. However, the (L5) relay is held by its secondary winding. When the (L) relay operates on the second dial closure, the (L4) and (L5) relays both release. Any possibility of the (L4) relay releasing before the (L3) relay and, thereby, preventing the release of the (L3) and the (L5) relays, is prevented by locking the secondary winding of the (L4) relay to a front contact of the (L3) relay. This cycle repeats every two pulses of the digit and from this it should be noted that the (L5) relay is operated for the first, third, fifth, etc., pulses of the digit and that each even pulse, second, fourth, sixth, etc., releases the (L5) relay.

The pulses of each digit are counted on the pulse (P1) to (P6) relays which are operated in rotation by alternate closures of the front and back contacts of the (L5) relay. A (P-) relay locks until it is released by the operation of the next (P-) relay or by the functioning of the (RA) and (SM1) relays. At the end of a string of pulses for one digit, the (P-) relays which are operated for each digit are shown in Table I. The figures shown under the pulse column are the pulses of the number dialed and the notation 0 (operate),

# REGISTRATION OF CALLED NUMBER

R (release), H (hold) and - (normal) under the L, L3, L4, and L5 columns indicates the condition of these relays.

TABLE I

Pulse	L	L3	L4	L5	(P) Rel. Operated
1	R O	O H	- -	- O	(P1)
2	R O	R -	O R	H R	(P2)
3	R O	O H	- -	- O	(P3)
4	R O	R -	O R	H R	(P4)
5	R O	O H	- -	- O	(P5)
6	R O	R -	O R	H R	(P5 - P6)
7	R O	O H	- -	- O	(P1 - P6)
8	R O	R -	O R	H R	(P2 - P6)
9	R O	O H	- -	- O	(P3 - P6)
10 (zero)	R O	R -	O R	H R	(P4 - P6)

When the dial returns to normal between digits, the (L) relay is operated for an appreciably longer time than between pulses in dialing one digit, operating the (L1) and (L2) relays and releasing the (RA) relay. The (RA) relay releasing operates the (RA1) relay and one of the selecting magnets depending upon which (P-) relay has remained operated. The (P-) relays are not released until the (SM1) relay operates.

## RECORDING THE DIGITS

When the selecting magnet operates under control of the (P-) relays for the first digit, it operates the (SM1) relay as shown on Fig. 2. The operation of the (SM1) relay locks the operated selecting magnet and releases the (P-) relays for the next digit. The (SM1) relay operated, operates the (SM2) relay which, in turn, causes the (SM3) relay to operate. The (SM3) relay operated releases (SM1) relay and closes the circuit through the secondary winding of the (SM2) relay through the (RA3) relay operated to operate the (A) hold magnet. The (AA) hold magnet is also operated by the (SM3) relay. The (RA3) relay is operated at the time the "A" digit is being recorded, having been operated by the recording of the frame indication on the (F) hold magnet. The (A) and (AA) hold magnets lock to ground thereby short circuiting the (SM2) relay causing it to release which, in turn, releases the (SM3) relay. The interval elapsing between the closure of the

selecting magnet contact and the closure of ground to the winding of the holding magnet, during which the operations of the (SM1), (SM2), and (SM3) relays take place, insures that the selecting finger is in position to be securely engaged before the holding magnet is operated. Similarly the interval during which the (SM2) relay is releasing following the closure of the holding magnet off-normal contact insures that the selecting finger has been securely engaged before the selecting magnet is allowed to release.

The operation of the (AA) holding magnet operates the (AL1) relay which disconnects dial tone from the subscriber line. The (AA) vertical provides additional contacts for the (A) vertical. The functioning of the (SM3) relay causes the (RA2), (RA3), (RA4), and (RA5) relays to function on successive operate and release conditions. These operations together with the off-normal contacts on the various holding magnets and the contacts on the (CL) and (HL) relays causes the recording of the various digits on the correspondingly designated verticals. The functioning of these relays is shown in Table II for the various digits to be recorded. It should be noted that the (SM3) operates at the beginning of the registration of a digit and releases at the end of the registration of a digit.

TABLE II

Reg.	(SM3)	(RA2)	(RA3)	(RA4)	(RA5)
F	O R	O H	- O	- O	- -
AA & A	O R	R -	H R	H H	- O
B	O R	O H	- O	H R	H H
C	O R	R -	H R	- -	H R
TH	O R	O H	- O	- O	- -
H	O R	R -	H R	H H	- O
T	O R	O H	- O	H R	H H
U	O R	R -	H R	- -	H R
ST	O R	O H	- O	- O	- -

The operation of the (C) holding magnet operates the (CL) relay and the operation of the (H) holding magnet operates the (HL) relay to obtain additional contacts. The (CL) relay provides a means of calling in the originating marker for decoding the call.

More details regarding the dialing and registration circuit are shown on Fig. 3.

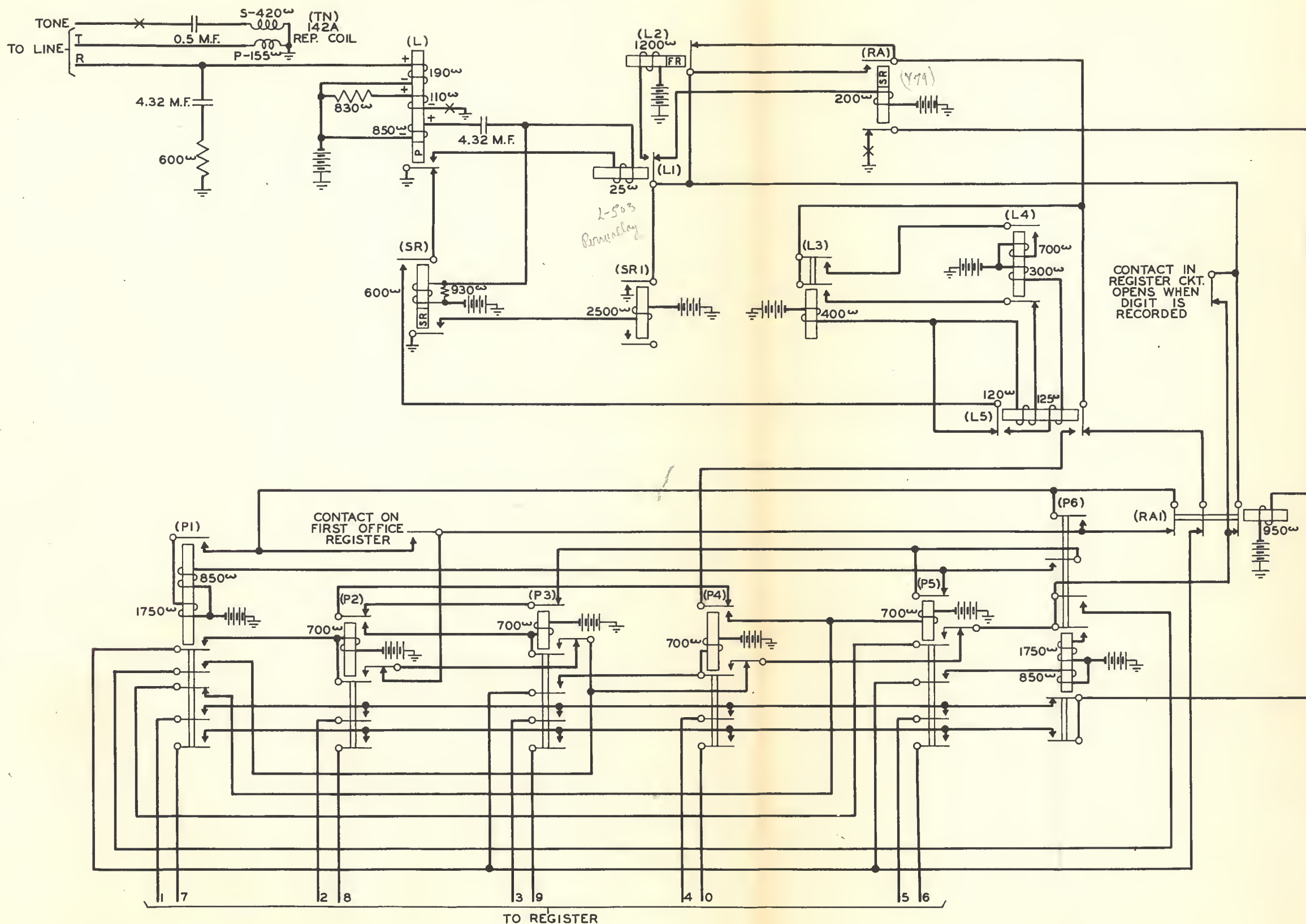


Fig. 1 - Dial Pulse Register Relays



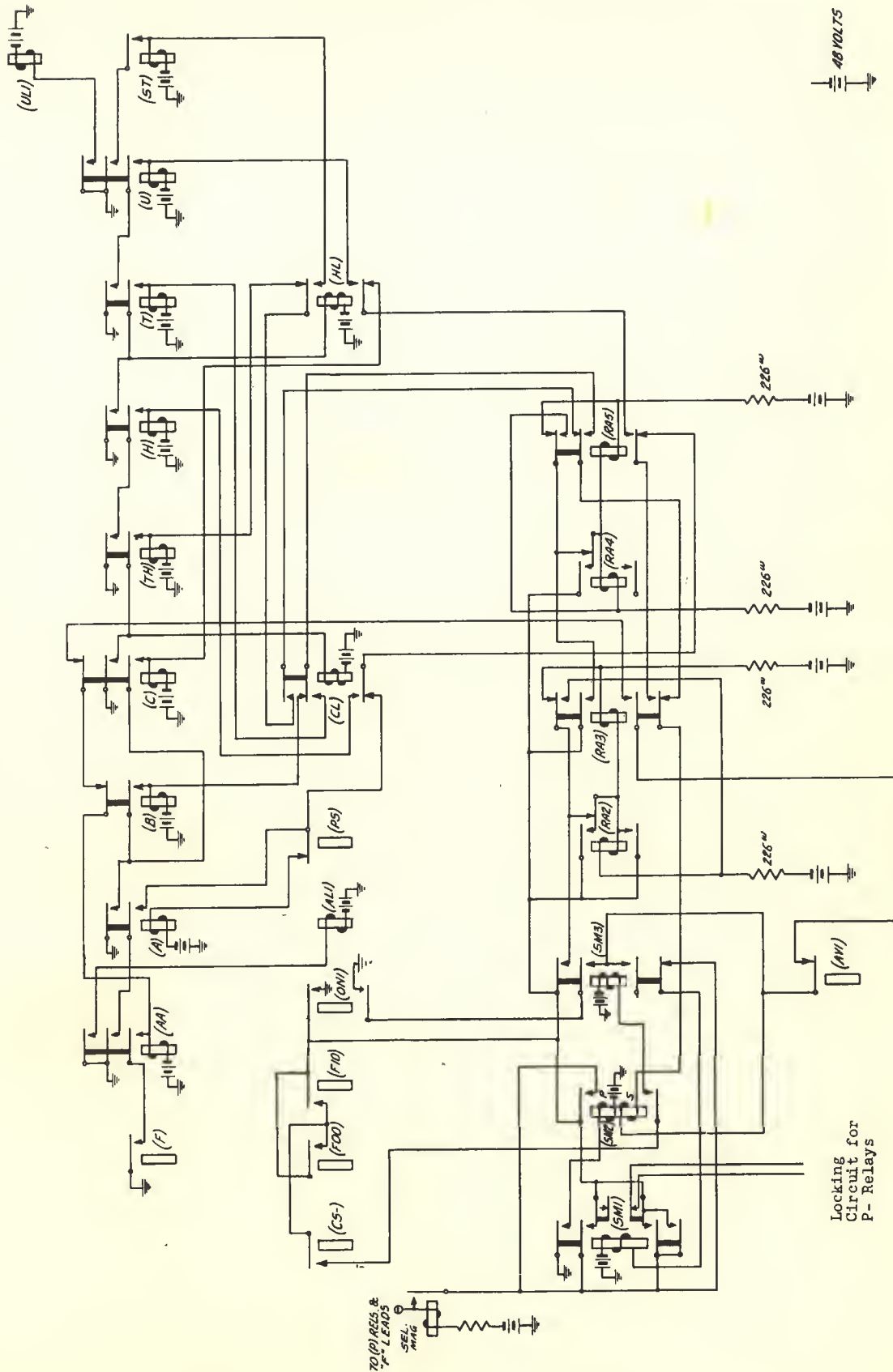


Fig. 2 - Subscriber Sender Operation Of Hold Magnets For Dialed Digits



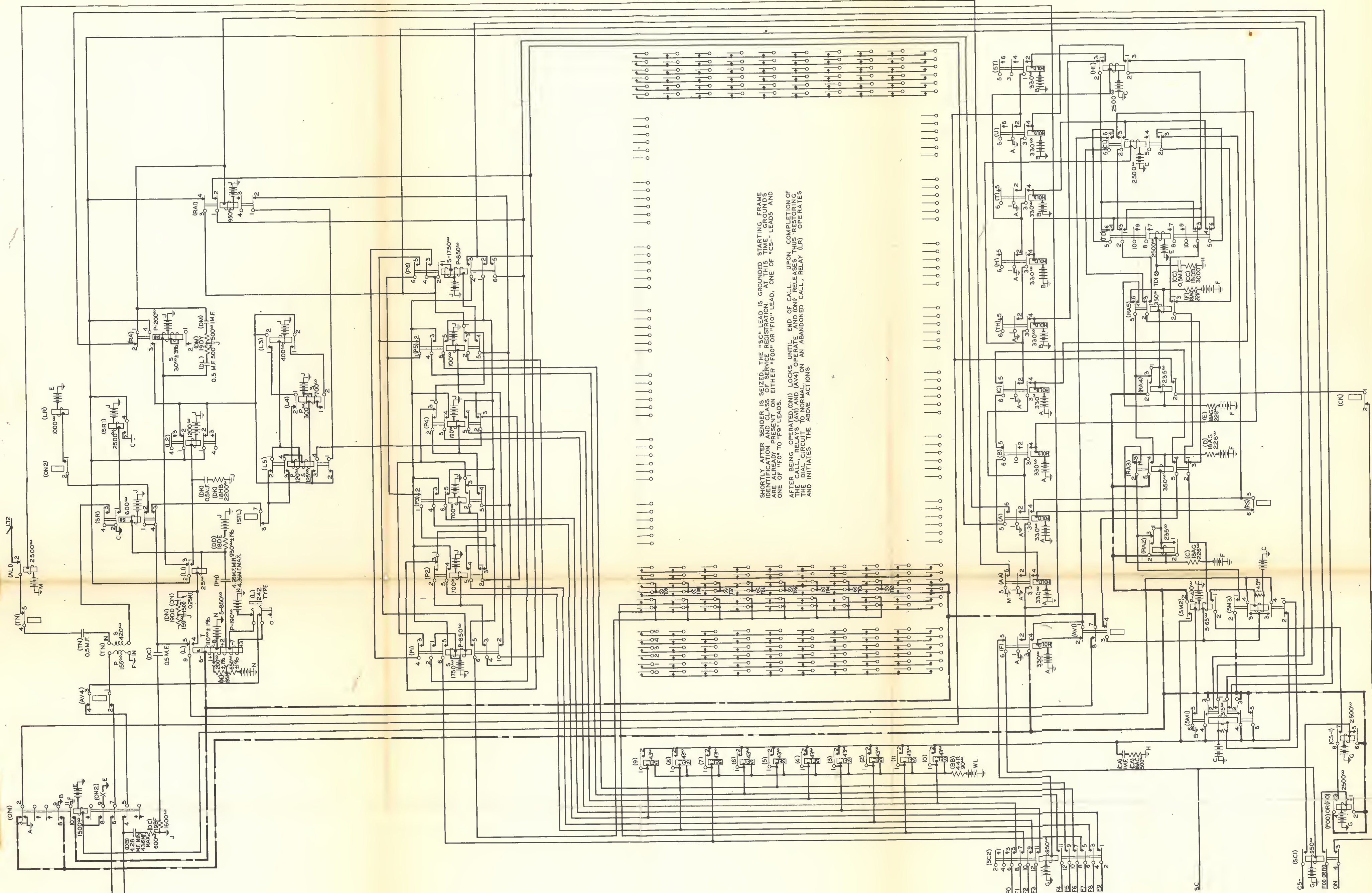


Fig. 3 - Dial Register Circuit



## CHAPTER 16 - SUBSCRIBER SENDER - INFORMATION TO ORIGINATING MARKER

The originating marker is used to translate the office code and to establish a connection between the district junctor and a desired trunk. In order for the marker to perform these functions, it is necessary for the subscriber sender to transmit the following information to the originating marker: The office code (A, B and C, digits); whether it is a first (no indication), second (AR) or third (OF) trial; the calling district frame number (F); the class of service (D) of the calling subscriber and an indication of whether a tip party (TP) message rate subscriber is calling.

### SIGNALING FOR A CONNECTION BETWEEN THE SENDER AND MARKER

When the subscriber sender requires a marker to assist in establishing a connection it connects battery to the (start) "ST" lead of the associated originating marker connector. As has previously been discussed, a sender not only requires a marker as soon as the dialing of the code is completed, but also when a second or third trial is demanded.

### CODE DIALING COMPLETED

The decoder start (DST) relay in the subscriber sender operates as shown on Fig. 1 when the operation of (CL) relay shows that the office code has been dialed, or when the (O) cross point on the (AA) register closes showing that zero has been dialed for a first digit, or when permanent signal (PS) relay operates to indicate that dialing has not commenced in the time allowed by the timing circuit. The (DST) relay operated connects battery to leads "ST" and "CBS" to the originating marker connector, with the effect that the latter connects the sender to an idle marker over about sixty leads as soon as the connector and a marker are available.

### SECOND TRIAL

If the marker encounters trouble in receiving information from the sender, in translating the office code, or in transmitting information to the sender, or if it finds all trunks of both regular and alternate routes to the desired point busy and also all overflow trunks busy, it sends a trouble release to the sender by grounding the trouble release "TRL" lead and so operates the (TRI) relay, which releases the (DST) relay, which breaks the "ST" lead, thereby releasing the connector and breaking all direct connections between the sender and marker. Lead "TRL" being

broken with the other leads, permits the (TR2) relay to operate in series with the (TR1) relay. The (DST) relay now reoperates with the result that a second connection is made through the connector to a marker. This may be to the same marker as before, but usually will be a different one, since the first marker holds itself busy momentarily after sending a trouble release. The (TR2) relay being operated on the second trial, lead "AR" to the marker will be grounded to notify the marker to use the alternate route to the desired point, if there is an alternate route. If there is no alternate route, the trunks in the original route will be tested in an order reversed to the order of test for the first trial. The second marker will now try to establish the connection.

If the first marker encounters either trouble or an all paths busy condition when trying to establish the connection to a chosen idle trunk or overflow trunk after its direct connection with the sender through the marker connector has been broken down, it sends a trouble release by grounding momentarily the "TR" lead through the district junctor and sender link. The (DC) relay being operated at that time causes the "TRL" lead to receive this ground, operating the (TR) relays in the same manner as if the lead had been grounded via the marker connector. This causes the release of the (DST) and (DRL) relays, the decoder release (DRL) relay having operated when the marker released its direct connection to the sender. The operation of (TR2) relay operates (DST) relay again with the result that a second connection is made through the connector to a marker. The (TR2) relay being operated on the second trial, lead "AR" to the marker will be grounded as mentioned above. The second marker will try to establish the connection.

If the first marker functions successfully and is dismissed but the sender in making selections beyond receives an overflow signal because of a distant panel type selector traveling to overflow or tell-tale, or because of some trouble affecting a crossbar terminating sender, the (AV2) and (AV3) relays will connect a ground for a moment only to the "TRL" lead. This momentary ground causes the (TR) relays to function as has been described.

For the brief time between a first and a second trial, while (DRL) relay is normal, all selection register relays in the sender are released and the ground on the "LR" lead through the sender link to the district is broken in order to release relays locked up in the district and allow them to be reused.

## NUMBER REGISTRATION

### THIRD TRIAL

If both first and second trials with the marker result in a trouble condition the "TRL" lead will be grounded a second time which will cause the (DRL) and (DST) relays to release and the (TR3) and (TR4) relays to operate. The (TR3) relay being operated on the third trial, "OF" lead to the marker will be grounded to notify it to establish a connection to an overflow trunk. The "AR" lead is also grounded on the third trial. The marker will send selection information to the sender, operate (DC) and (DRL) relays connect the district to an overflow trunk and release (DC) relay just as it would function for connecting to a regular trunk. In case it cannot find an idle overflow trunk, or finding one cannot find an idle path to it, it will nevertheless give a regular release, just as if it had succeeded in making the connection. On third trials, the trunk guard (TG) test in the sender is cancelled.

For a brief time between a second and a third trial, while relay (TR3) is operated and relay (TR4) is normal, the "LR" lead through the sender link to the district is broken in order to release relays locked up in the district and allow them to be reused.

If the third trial encounters any one of the conditions which cause a retrial, the "TRL" lead will be momentarily grounded a third time. The (TR1), (TR2), (TR3), and (TR4) relays all being locked up, this ground will shunt down and release (TR3) relay, but (TR4) relay will hold by its secondary winding. The (DST) relay releases and breaks the "ST" lead, releasing the marker connector if still engaged. The (TR3) relay cannot reoperate, neither can relay (DST), and the sender will be stuck.

### SEIZURE THROUGH MARKER CONNECTOR

With sender (DST) relay operated, battery is placed on the start lead to operate the (STS) and (CA1) relays in series as shown on Fig. 2. If some other connector circuit is not using the marker, operation of the (STS) relay causes (SA) relay to operate and in turn the (SB) relay. The (SA) relay operated closes through the start lead battery to operate the (DS) relay which releases (DA) and (DA1) relays in the marker. These relays released, start the timing circuit by operating the (TMS1) relay and also operates the (STX) relay. Relay (DMA) operates from the operated (DS) relay and in turn operates relay (DMB). This relay operates the (CBR), (CBS), and (CBT) relays in the marker which supplies ground to operate the (CB) relays of all originating marker connector circuits associated with it, with the exception of the one in use. This is accomplished by ground at the operated (DMA) relay shunting the resistance battery of the (CB) relay in use. The operation of the (CB) relay makes the marker busy to the connector.

With relays (SA), (SB), (STS), (DMA), (DMB), and (DS) operated, numerous leads are closed through from the sender to the marker,

the (SA), (SB), (DMA), and (DMB) relays are multi-contact relays

### REGISTRATION IN MARKER

As soon as the multicontact relays in the marker connector are operated the receiving leads are checked and the information is transferred to the marker. Ground from a back contact of the (CK4) relay over the "CK1" lead is connected to each of the "A1", "A2", "A4", "A5", "TP", "AR", and "OF" leads in the sender circuit as shown on Fig. 3 which are not already grounded by the call being set up. For example, if the call was not originated by a tip party message rate subscriber the (TP1) relay would be normal and the "TP" lead would get its ground from the "CK1" lead, if the (TP1) relay were operated, it would ground the "TP" lead. A similar condition is true for the (TR2) and (TR3) relays and the alternate route "AR" and overflow "OF" leads. Since all the "A1", "A2", "A4", "A5", "TR", "AR", and "OF" leads are grounded on each call, the correspondingly designated relays in the marker will operate in turn operating the (CK1) relay. This checks that these leads are all continuous. The (CK1) relay operating operates (CK4) relay, which removes ground from the "CK1" lead permitting all relays which are not required for the call to release, if any one of these unused leads is grounded then no relays would release and the call would block indicating trouble. On no normal service call will the (A1), (A2), (A4), and (A5) relays all be required consequently, the (CK1) relay will release and in so doing operate the (CK6) relay.

The "B1", "B2", "B4", "B5", "C1", "C2", "C4", and "C5" leads are checked using the (CK2) and (CK5) relays as indicated on Fig. 4 in a manner similar to that described above for the "A", etc., leads and (CK1) and (CK4) relays. The "F1", "F2", "F4", "F5", "F10", "D1", "D2", "D4", and "D8" leads are checked using the (CK3) and (CK4) relays. When at least one recording relay in each chain releases the chains are broken and relays (CK1), (CK2), and (CK3) release, but a false ground preventing the release of any relay in one chain will prevent the release of the (CK1) and (CK3) or (CK2) relays. The release of relays (CK1), (CK2), and (CK3) with (CK4) and (CK5) remaining locked up, connects ground through contacts not shown on the sketch to the contacts of the recording relays so that the originating marker can proceed with the decoding functions in accordance with the combinations of (A), (B), (C), (D), and (F) recording relays which remain operated. The release of the (CK1) and (CK3) relays with the (CK4) relay remaining locked up operates the (CK6) relay to cause operation of the start relays (ST1) and (ST2).

The relays that would be operated for the various digits of the office code dialed, the district frame number and the class of service number are indicated as follows. The numbers of the relays add up to the number used. If the district frame number were between 10 and 19, the (F10) and (F10') relays would also be operated.

Num- ber	Relays Operated				D Class Of Service
	A Digit	B Digit	C Digit	F Frame No.	
0	1-4-5	None	None	None	<del>None</del>
1	1	1	1	1	1
2	2	2	2	2	2
3	1-2	1-2	1-2	1-2	1-2
4	4	4	4	4	4
5	5	5	5	5	1-4
6	1-5	1-5	1-5	1-5	2-4
7	2-5	2-5	2-5	2-5	* 8
8	1-2-5	1-2-5	1-2-5	1-2-5	1-8
9	4-5	4-5	4-5	4-5	2-8
10	-	-	-	10'	1-2-8
11	-	-	-	1-10'	4-8
12	-	-	-	2-10'	1-4-8
13	-	-	-	1-2-10'	2-4-8

## GROUNDING THE CODE POINT

When the check (CK) relays have performed their function the code points are grounded as

shown on Fig. 5. There are code points for the possible dialing of codes 200 to 999 inclusive, and also permanent signal and zero operator. One of the fifties (H-) relays operates depending upon whether the (B5), (B5') relays are operated or not and the operated (A-) relays. The (B) relays operated cause operation of one of the tens (TN) relays. The operation of the (C) relays then grounds the desired code point.

## RECORDING CLASS OF SERVICE AND DISTRICT FRAME

The operation of the (D) relays operates a service (S) relay as shown on Fig. 6. The operation of the (F) relays operates a district frame (DF) relay as shown on Fig. 6. The (DF) relay locks since the district frame indication is required after the decoding function has been performed and the decoder portion of the marker has been freed to handle another call.

\* Used by "A" senders only.

14

15

16

17

18

19

4-10'

5-10

1-5-10

2-5-10

1-2-5-10

4-5-10.

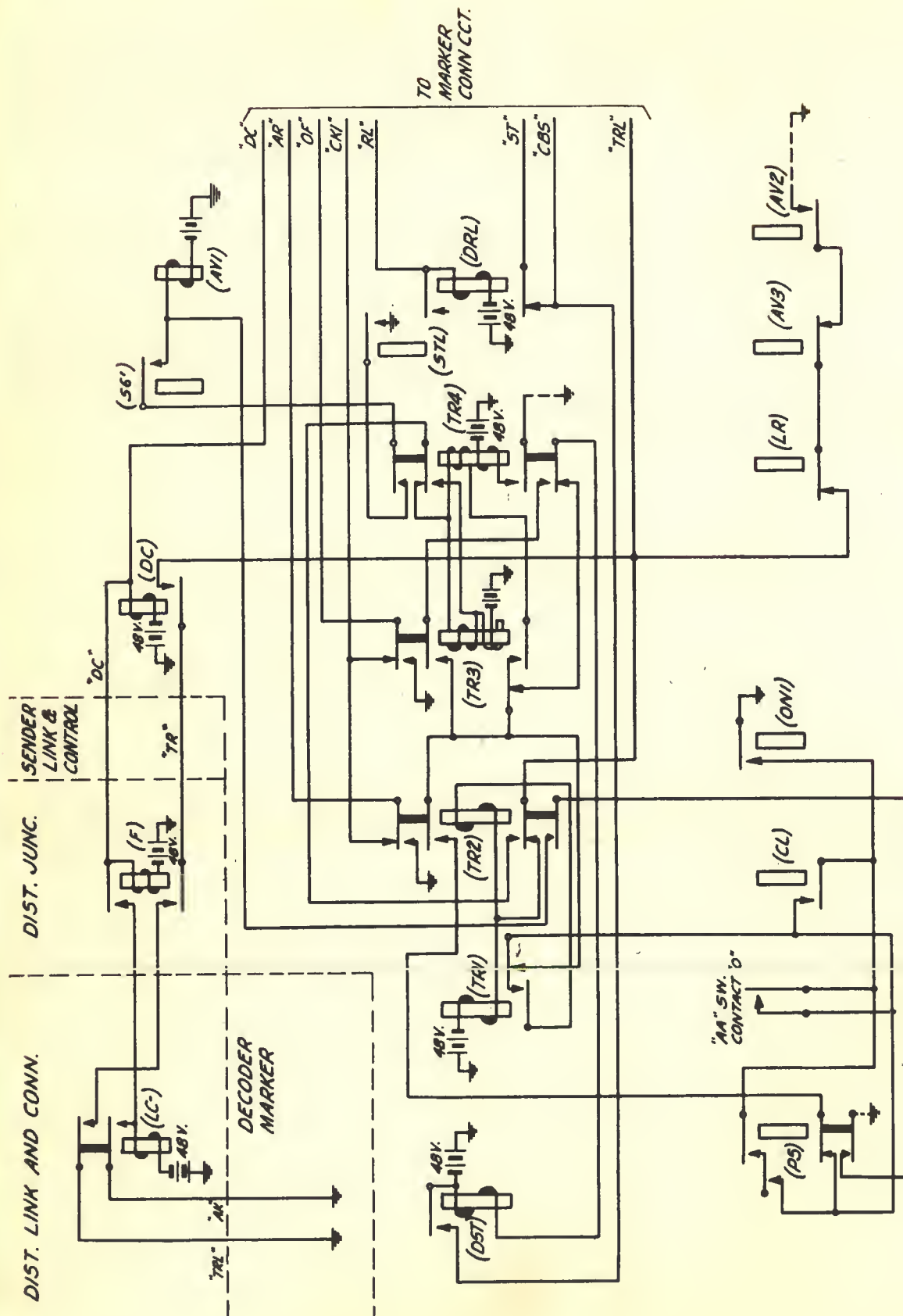


Fig. 1 - Subscriber Sender Operation Of The Decoder Start Relay (DST) Also Operation Of (TR) Relays From "TRL" Lead To Give Alternate Route Or Overflow Indication To Decoder Marker

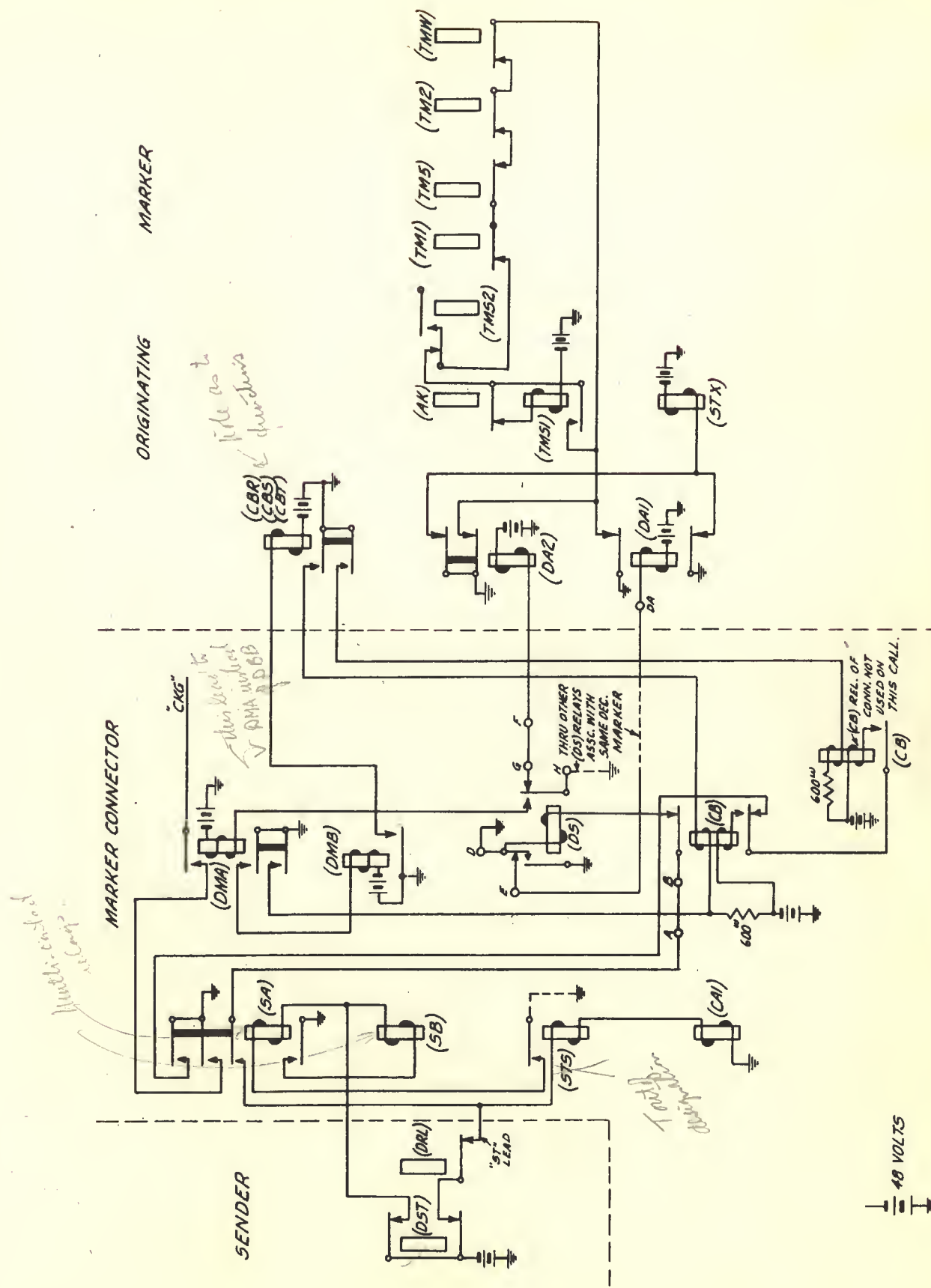


Fig. 2 - Originating Marker Seizure By Marker Connector

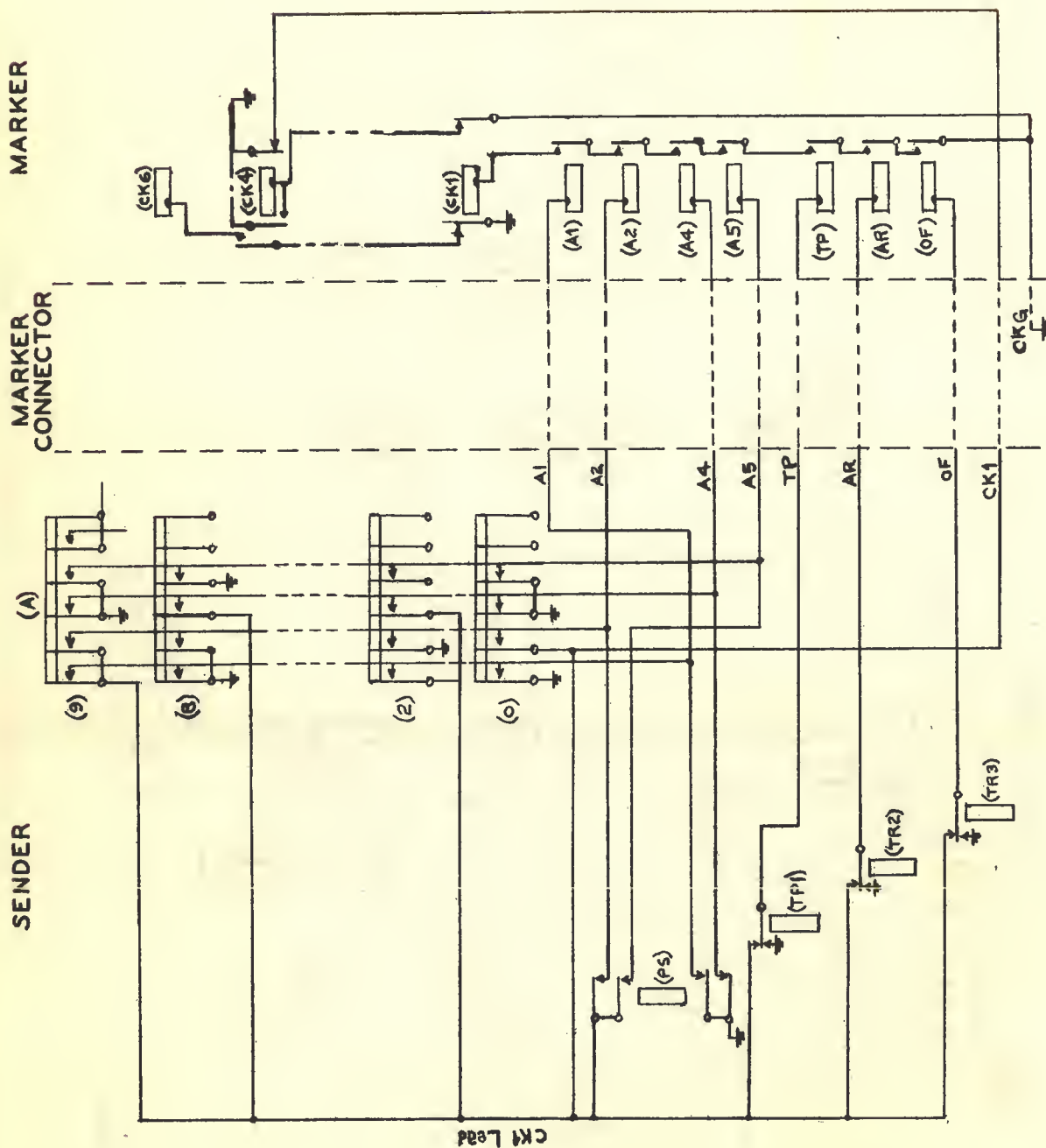


Fig. 3 - Check of "A-" Leads

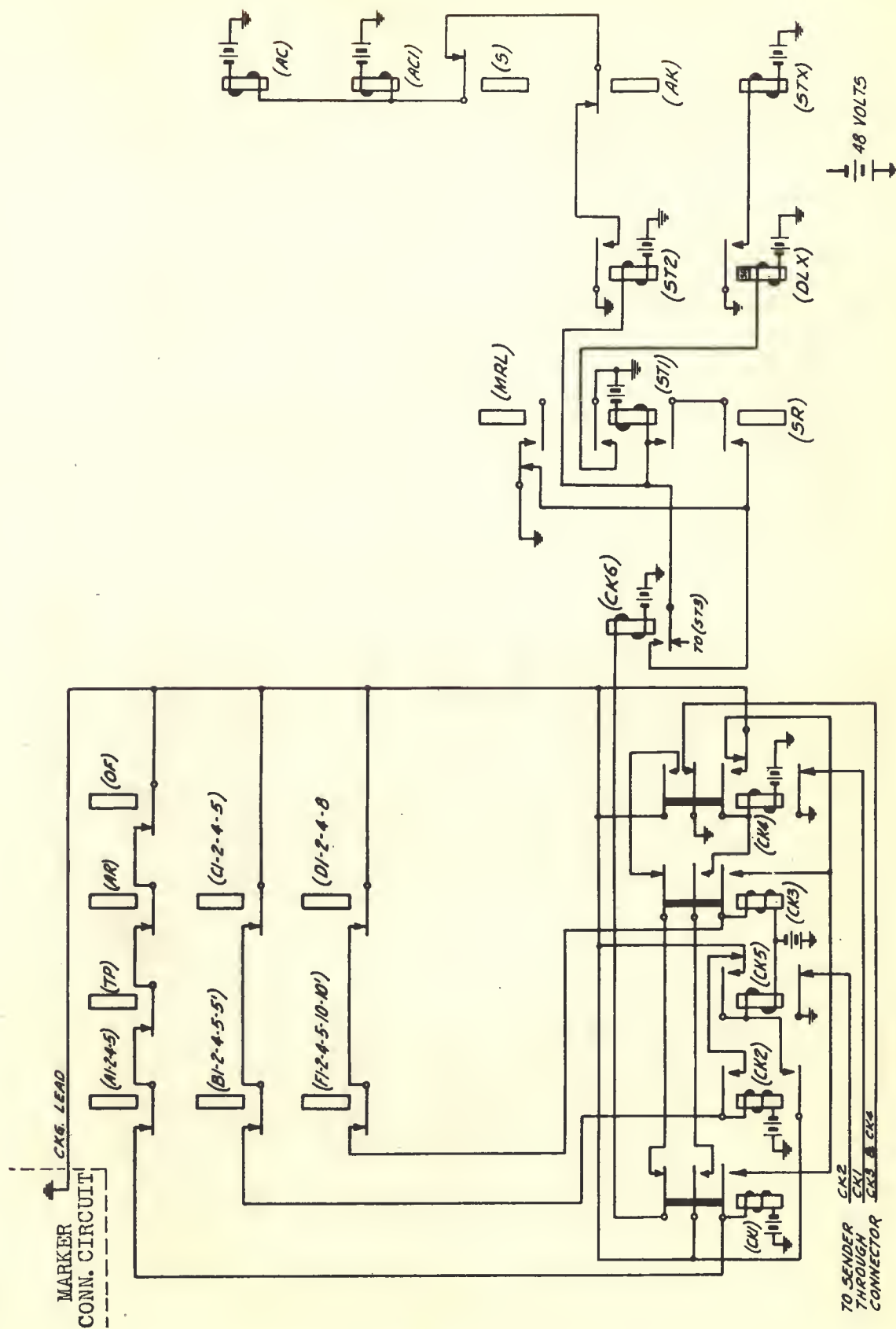


Fig. 4 - Originating Marker Receiving Information From Sender and Check of Registration Leads

REGISTERING RELAYS

TENS RELAYS

FIFTIES RELAYS

CROSS CONN TO ROUTE RELAYS

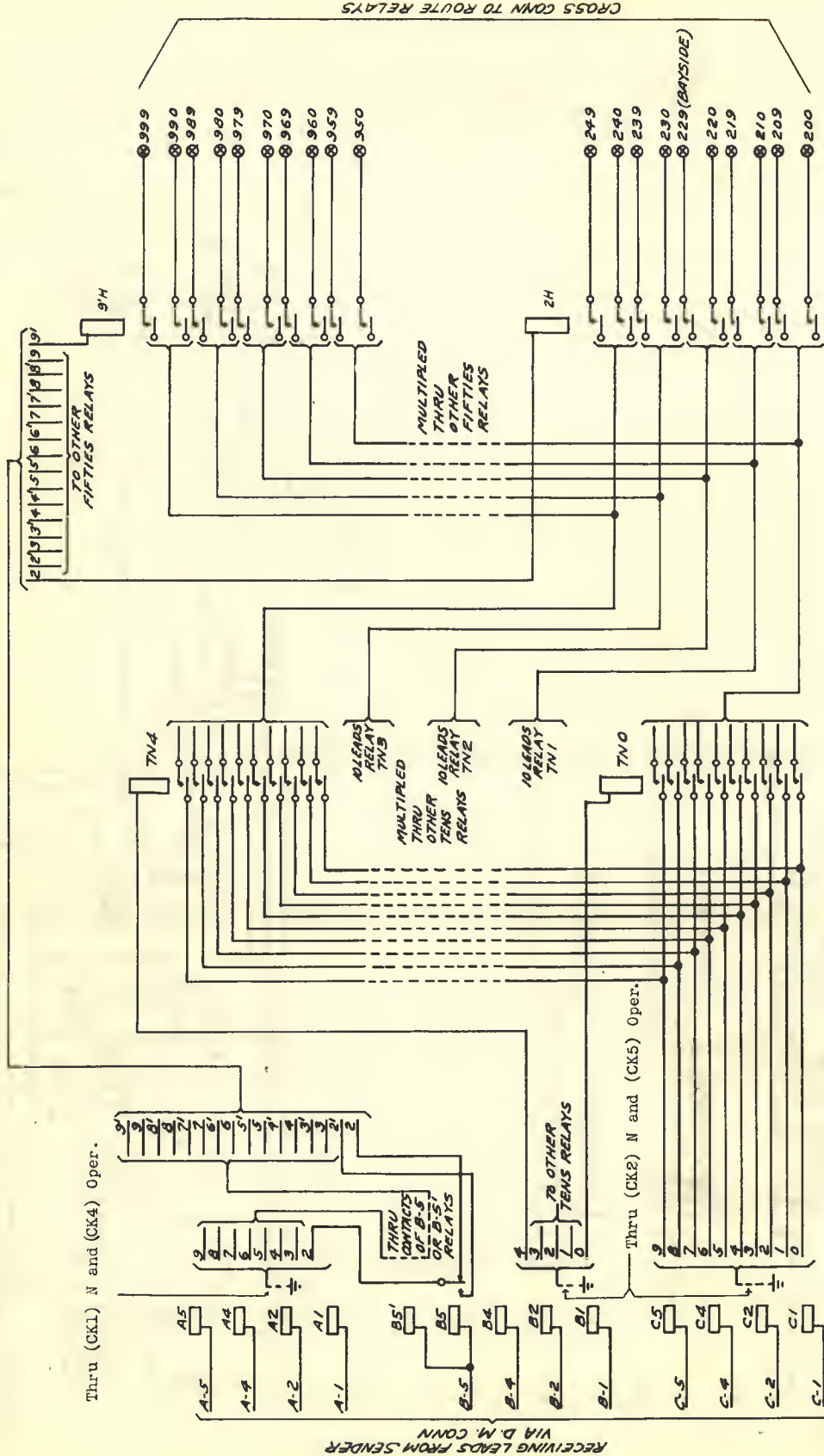


Fig. 5 - Marker Circuit - Grounding a Code Point

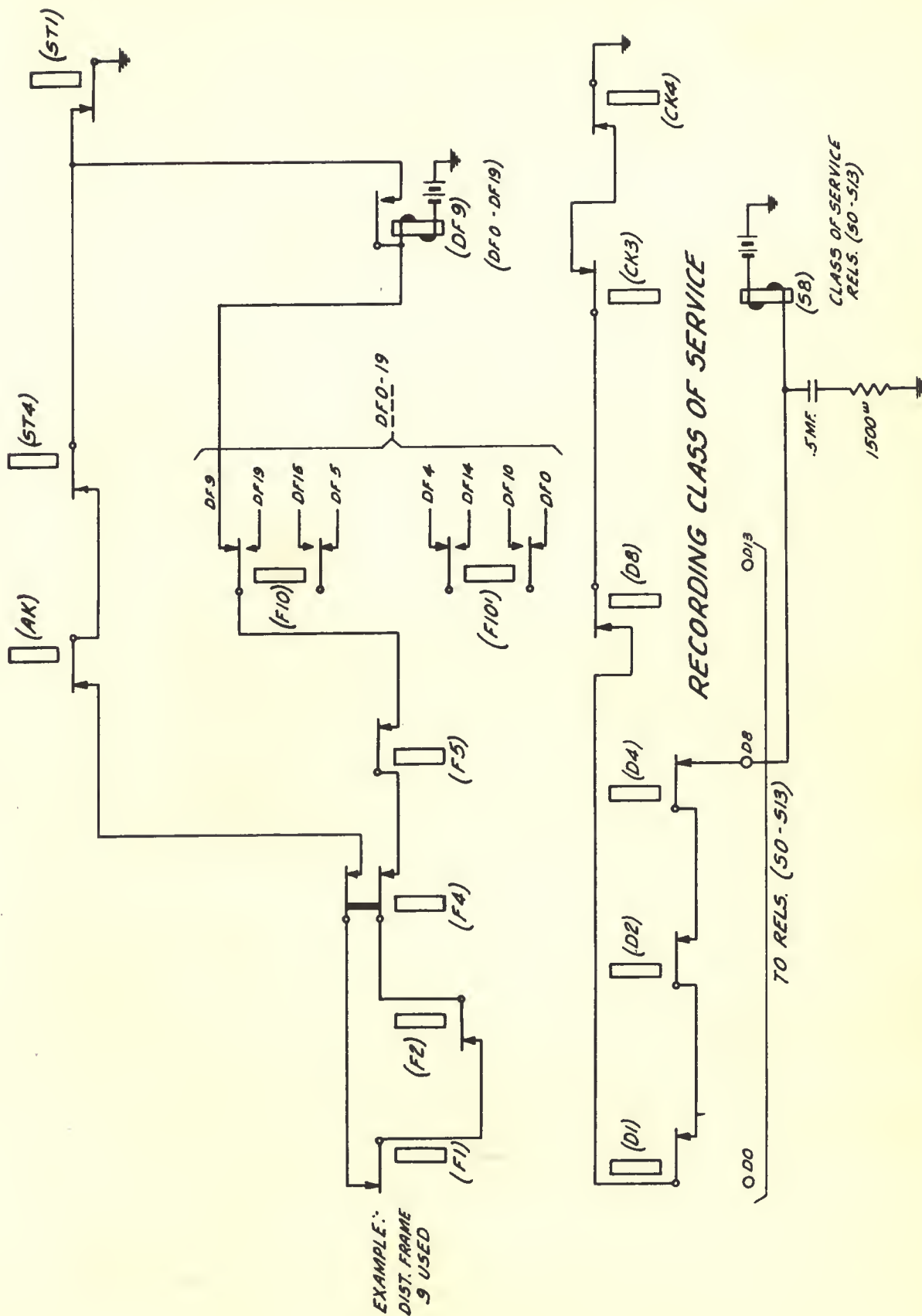


Fig. 6 - Recording District Frame Indication



## CHAPTER 17 - ORIGINATING MARKER - TRANSLATION OF OFFICE CODE

The principal advantage of the crossbar and panel systems over the step-by-step system is that of flexibility of the trunking facilities. The trunks to a central office may be located irrespective of code number with respect to other office code numbers. The outgoing trunks may also be readily relocated to accommodate seasonal traffic. This feature is made practical by the decoder portion of the originating marker whereby the direction of a call to a desired central office is entirely under control of cross-connections of the code point and the contacts of the associated route relay.

There is a large cross-connection field on each route relay bay for each marker as mentioned in Chapter 9. This field has terminals for all code points, for both ends of the winding for each of the 100 route relays on the bay, and for the fourteen contacts of each route relay. All of the terminals to which the route relays cross connect are also multiplied to each of the route relay bays so that the cross-connections are confined to a single bay. There are other cross-connections which are common to the marker that are made on the cross-connection field associated with the common equipment bay of the marker.

Route Relays are assigned to code points on the basis of twelve items of information required by the sender together with four items required by the marker for locating the associated trunk on the office multiple and a fifth special item. The sender items are the six major (class of call, compensating resistance, and first and second office selections) and six minor (use of 2 wire office, trunk guard relay required, station delay, skip first and/or second office selection and second office compensating resistance) selections. The same route relay can be employed for any number of code points provided there is no difference in any of these items. A different route relay is required for any code point differing in one of the seventeen items mentioned above from other code points.

Routes (Multiple) for Special Codes: It may be desirable for such codes as zero operator, long distance operator, permanent signal, vacant code and denied route to have more than one routing in accordance with the class of service of the calling subscriber. When coin and non-coin service is provided, it is necessary from a circuit operation standpoint to have at least two routes for long distance and vacant code calls to segregate the coin service. Under this condition, one or two route relays depending on the number of sub-groups in the trunk group are required for each routing for each code. These code points (C) are connected through the service (S) relay

contacts to the winding of the (R) relay and then through the (ZOT), (ZNC), or (ZPS) relay to battery as shown on Fig. 1.

Routes with Different Zone Treatment: A large percentage of the codes will require only one route but will require various charge conditions depending upon the class of service of the calling subscriber. For these codes, one or two (R) relays will be required for each original route, depending upon the number of sub-groups in the trunk group. A number of codes may use the same route relay provided the information for the seventeen items is identical. This often applies for codes routed through tandem points. For these codes the code points are cross connected direct to the route relay winding and then through the contacts of the service relays to the (ZNC), (ZTC), (ZKP), (ZDRC), (ZOV), (ZTW), (ZAR), and (ZA) to (ZJ) relays. In a few cases such as codes 411 (Information) 811 (commercial), 711 (dial and ringer test line) and certain district test lines which always require operator transmission or no charge settings, it is not necessary to cross connect through the contact of the service relays, the "R" terminal connecting direct to (ZOT) or (ZNC) relays. Alternate route, and overflow route relays are cross connected from the "RA" terminals of numerous (R) relay contacts to the assigned (R) relay as shown on Fig. 1. For overflow conditions, three routes relay are assigned, however, all will probably use the same trunks hence the one route. These three route relays are used to provide various stations delays so that the sender will not close through the district before dialing is completed. One is reserved for overflow trunks for one or three digit operator codes. The second is reserved for overflow trunks for codes requiring no stations delay and the third is reserved for overflow trunks for codes requiring stations delay for party lines and numbers over 9999.

Sub-groups in Trunk Group: If the entire trunk group is in one group (maximum forty trunks) only one (R) relay is assigned. If the trunk group is divided into two sub-groups (maximum eighty trunks) only one (R) relay is needed. If the trunk group is divided into three to thirteen sub-groups, two (R) relays are required, the second (R) relay is used for one and only one sub-group used as a "common" or overflow sub-group for the other sub-groups. One (R) relay will be in GSG1 (ground supply group 1) and the second one in GSG2 if an original route with an alternate route. These two (R) relays will be in GSG3 and GSG4 if the route is an alternate route or if it is an original route with no alternate route. For permanent signal or overflow routes the (R) relay is always in GSG5 in which case only one (R) relay is used for each route, the common sub-

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group never being supplied and the maximum number of sub-groups being twelve (480 trunks). Permanent signal route relays are placed in GSG5 so that in case of a cable failure, the overflow trunks will not be made busy by permanent calls with no indication of the trouble.

**GSG (Ground Supply Group):** All of the (R) relays are connected in GSG1 to GSG5 inclusive. These relays are assigned at the time of installation and their armature contacts are wired to the assigned ground supply group (G) and (GS) relays. The conditions mentioned above, together with whether the route is an original route with or without an alternate route, determine which route relays may be assigned.

- (a) Original routes which have an alternate route are always assigned (R) relays in GSG1. If there are three to thirteen trunk sub-groups, an (R) relay in GSG2 must also be assigned.
- (b) All alternate groups are assigned (R) relays in GSG3 and a second (R) relay in GSG4 if there are over two sub-groups in the trunk group.
- (c) Original routes which do not have an alternate route are assigned (R) relays in GSG3 and also in GSG4 if there are more than two sub-groups in the trunk group.
- (d) Permanent signal and overflow trunk routes are assigned (R) relays in GSG5.

Cross-connections for (R) relays in GSG2 and GSG4 are from the "RA" terminal of the associated relay in GSG1 and GSG3 respectively, to the "RC" terminal of the assigned (R) relay and from its "R" terminal to the "ZAR" terminal, which is direct battery (see Fig. 1). For the alternate route (R) relay in GSG3, it is cross connected from the "RA" contacts of the (R) relays whose codes have this route in question as its alternate route. The "RA" contact to be used is the one in GSG2, if provided, otherwise in GSG1. The (R) relays in GSG2 and GSG4 are always cross connected to the ZAR battery.

**CG (Code Group):** A large number of codes may be grouped together through the "CG" punchings to one (R) relay. Codes which are reached only through a single full selector or manual tandem point and which have identical station delay and zone charge conditions require only one route, (one or two (R) relays). One route through a tandem point may be used as an alternate route for a number of codes whose stations delay requirements are identical.

**Alternate Route through 2 Wire Office:** In case the alternate route is through an office selector and the original route is not through an office selector, the one or two (R) relays of the alternate route may be common to all codes having identical beyond office compensation, and TG or MTG requirements. Under this condition the original route relays provide office brush and group selections which are skipped by the "SP" (special) terminal cross-connection during original route tests.

**Codes Available only to KPA Operator:** Direct trunks from the "A" switchboard to full selector panel or crossbar incoming trunks and to full selector or manual PCI tandem centers do not require a marker; hence no route relays are involved. These trunks are compensated to meet minimum trunk resistance requirements. Codes called through KPA district junctors will use the same route relays as do the regular subscribers for all codes which are directly available to some subscribers. Codes available to operators but not directly available to any subscriber such as those to offices in zones beyond zone "J" and which are reached through a KPA district must have a separate (R) relay assigned. Any code call which an operator can complete through a KPA district junctor cannot be completed through a direct trunk to a 2 wire office selector.

For codes completed through direct trunks to 2 wire office centers (R) relays (one relay per code) are required. No alternate routes are provided for these trunks. For codes called through a direct trunk to a 2 wire office center, their (R) relays are cross connected through the operator's (S) relay contacts to the "ZTW" punching; all other corresponding "S" terminals should be cross connected to the "ZDRC" punching so that dial subscribers dialing this code would be routed to an operator. The "ZTW" terminal cross-connection is an indication to the marker that only decoding is required and marker functions are to be skipped.

## ASSIGNMENT OF SERVICE RELAYS AND THEIR CONTACTS

**Service Relay Windings:** Service relays are assigned to different classes of subscriber service to provide a means in the marker for handling the various calls as determined by the service requested by the subscriber and to differentiate between the types of subscriber lines as required for circuit reasons. The operation of the service relays depends upon the assignment of the vertical files and wiring in line link circuits, the wiring in the subscriber sender link, the subscriber and KPA senders and the markers. The "D" terminal in the marker must be cross connected to the "SW" (service relay winding) terminal of the assigned (S) relay. For circuit reasons, it is necessary to segregate coin and non-coin lines. The KPA operator also requires a separate class of service. For convenience in handling calls to the special service or long distance operators, it may be desirable to divide the coin lines (CN) into single slot (SS) and multislot groups (public and semipublic). It may be desirable to segregate the subscribers as regards the scope of area of service, i.e. flat rate (FR) message rate local (MR) extended area (XA), multicharge service (ZONE) and rural (RU). Otherwise, in general, the service relays are assigned according to the service requested by the subscriber. A class of service for 2 party message register lines is required in the sender to control when party test is required. However, the 2 party message and the individual message rate service indications from the sender may be combined in one service relay in the marker.

**Service Relay Contacts:** A service relay contact is used in the circuit of the (R) relay windings for original routes except for a few codes such as 411 and 811 which will have only one route and the same charge to all subscribers and operators. The armature springs for like numbered contacts on all service relays are strapped together and the associated terminal is designated "SC" (service common). On codes which have multiple routings, these (S) relay contacts are used to provide a separate route for the various classes of service as shown on Fig. 1 for routes for special codes. In general, however, these (S) relay contacts are inserted between the (R-) and (Z-) relays to provide a variation in the charge and transmission conditions established in the district junctor as shown on Fig. 1 for routes with different zone treatment. The codes of various offices may be grouped according to zone and charge conditions permitted by the various classes of service. All codes requiring the same treatment in the marker may then use one "SC" terminal so that, other than for multiple registration, only a few "SC" terminals will be required for the entire office.

#### ASSIGNMENT OF "Z" TERMINALS

Various "Z" terminals are furnished so that the marker may control the transmission set-up in the subscriber district junctor, the charge including denied service for the call and various circuit features. Cross connect to the following "Z" terminals under the conditions indicated below, (see Fig. 10).

(a) **ZOT:** All codes requiring operator transmission in the subscriber district junctor circuit. In general, ZOT will be cross connected direct to the route relay winding.

(b) **ZNC**

(1) Talking "No Charge" for all classes of subscribers other than ZOT.

(2) Coin class of service whether "charge" or "No Charge".

(3) All codes completed through key pulsing district junctors.

(c) **ZTC:** All codes for which the subscriber is to be charged one message unit. This includes individual and 2 party message rate service with or without timing for local calls. It may be used for flat rate subscribers who have a limited flat rate area and the privilege of calling into a one message unit zone on a message rate basis.

(d) **ZA to ZJ:** Codes beyond the flat rate or single message unit zone as specified for zone charge conditions.

(e) **ZPS:** Permanent signal code. In general, ZPS will be cross connected directly to the winding of the route relay.

(f) **ZTW:** All destinations reached only through a direct trunk to a 2 wire office center from the "A" switchboard, (cancels marker function).

(g) **ZKP:** Overflow signal routes, vacant codes zero operators or repair service codes and for permanent signal code (assigned for test purposes) when KPA operator class of service is used in order to give the operator a reorder signal.

(h) **ZOV:** All overflow signal routes when any subscriber class of service is used.

(i) **DRC:** All codes for which the class of service is denied an automatic connection and is therefore routed to the special service operator.

(j) **ZAR:** All alternate routes in ground supply group 3 and also all route relays in ground supply groups 2 and 4.

(k) **RMR-ZMR:** The "RMR-ZMR" terminals are used to cancel the test for ground on the "M" (message register) lead, and is used on the following service relays.

(1) Service relays for all coin subscribers.

(2) Key pulsing "A" operator service relay.

(3) Service relays for all flat rate subscribers whose "M" lead is not grounded.

#### GROUND SUPPLY GROUP OPERATION

The action of the five ground supply groups is shown on Fig. 2. The (R<sub>1</sub>) relay is operated from a grounded code point. The information for connecting to the office frames and the trunks thereon has been furnished by the (R<sub>1</sub>) relay as will be described later. For the purpose of describing the function of the five ground supply group, we are assuming that all five are used for this code which means there are over eighty trunks in both the original and alternate trunk group otherwise, GSG2 and GSG4 would not be used. We are assuming that all trunks including overflow trunks are busy.

When all trunks in a sub-group are busy, the trunk busy (TB) relay operates as will be shown later. The (TB) relay operated, operates the (TB1) relay which looks to the (TB) relay and operates the (G1) and (GS1) relay. The operation of the (G1) and (GS1) relays opens all of the leads to contacts of the (R<sub>1</sub>) relay except the "RA" contact which is closed. The opening of the "ST" lead releases the connection to the pair of office frames which in turn disconnects the trunk test relays and in turn the (TB) relay. The release of the (TB) relay releases the (TB1) relay which operates the (R<sub>2</sub>) relay in GSG2, closing through another group of leads which are grounded by (G2) and (GS2) relays normal, as shown on Fig. 3. The relay operations for progressing from one ground supply group to another when all trunks are busy is shown on the next page.

# TRANSLATION

Trunk Sub-group Busy	(TB) Relay	(TB-) Relay	Route Relay Operated	(G) Relay Operated	(GS) Relay Operated	Trans- lation leads
1st Orig.	O	(TB1)O	R <sub>1</sub>	1	1	open
	R	(TB1)R	R <sub>1</sub> , R <sub>2</sub>	1	1	closed
2nd Orig.	O	(TB2)O	R <sub>1</sub> , R <sub>2</sub>	1, 2	1, 2	open
	R	(TB2)R	R <sub>1</sub> , R <sub>2</sub> , R <sub>3</sub>	1, 2	1, 2	closed
1st Alt.R	O	(TB3)O	R <sub>1</sub> , R <sub>2</sub> , R <sub>3</sub>	1, 2, 3	1, 2, 3	open
	R	(TB3)R	R <sub>1</sub> , R <sub>2</sub> , R <sub>3</sub> , R <sub>4</sub>	1, 2, 3	1*, 2, 3	closed
2nd Alt.R	O	(TB4)O	R <sub>1</sub> , R <sub>2</sub> , R <sub>3</sub> , R <sub>4</sub>	1, 2, 3, 4	1, 2, 3, 4	open
	R	(TB4)R	R <sub>1</sub> , R <sub>2</sub> , R <sub>3</sub> , R <sub>4</sub> , R <sub>5</sub>	1, 2, 3, 4	1*, 2, 3, 4	closed
Overflow	O	(TB5)O	R <sub>1</sub> , R <sub>2</sub> , R <sub>3</sub> , R <sub>4</sub> , R <sub>5</sub>	1, 2, 3, 4	1*, 2, 3, 4	closed

\*The (GS1) relay is released when the alternate route is through a 2 wire office center and the original route is not.

The operation of the (TB5) relay provides a release signal to sender as shown on Fig. 5. If the trial is a first or second trial the (ST3) relay is not operated and the (XRL) relay operates giving a trouble release. If it is a third trial the (ST3) relay is operated and the sender is given a regular release.

## THIRD TRIAL OPERATION OF GSG

If the call is a third trial both the "AR" and "OF" leads are grounded as shown on Fig. 5. Thus operating the (R<sub>1</sub>), (R<sub>2</sub>), (R<sub>3</sub>), (R<sub>4</sub>), and (R<sub>5</sub>) relays at the beginning of a call testing only the overflow trunk group.

## ALTERNATE ROUTE THROUGH 2 WIRE OFFICE

It should be noted from Figs. 3 and 4 that the (GS1) relay operates through the (TWA) relay normal. This feature is provided in order to reduce the number of route relays when a large number of codes have an alternate route through a 2 wire office center with direct original routes. Under this condition, the office selection information is cross connected to the original route relay in GSG1 but is skipped because of the special "SP" cross-connection for the original route. However, when the alternate route is used, the (TWA) relay is operated when the route relays in GSG3 and GSG4 are in use. This releases the (GS1) relay thereby using "OB", "OG", and "CL" (also "SB" and "SG" not shown on Fig. 4) cross-connections made on (GSG1) route relay when using the alternate route relay in GSG3 or GSG4 since these relays do not have a cross-connection for the office selection and class of call terminals. This permits a large number of codes to use one alternate route in common.

## SECOND TRIAL OPERATION OF GSG

Fig. 5 shows how the original route relays in GSG1 and GSG2 are skipped on second trials. The "AR" lead is grounded operating the (AR) relay which operates (G1), (GS1), (G2) and (GS2) relays as shown as the (CK6) relay operates. (R<sub>1</sub>), (R<sub>2</sub>), and (R<sub>3</sub>) are then operated thus using the alternate route relay in GSG3.

## ASSIGNMENT OF ROUTE RELAY CONTACTS

Each route (R) relay has fifteen make contacts. The armature spring of each contact is wired to the contact of a (G) and (GS) relay in ground supply groups 1, 2, 3, 4, as shown on Fig. 3. All (R) relays associated with one ground supply group have their corresponding armature springs in multiple. The (R) relays are assigned to the various ground supply groups at the time of installation. The (R) relays in ground supply group 5 are used only for overflow and permanent signal routes. Fourteen front contacts of each (R) relay are individually wired to terminals in the cross-connection field. The "TB" terminal of all (R) relays are connected directly to the (TB) relay contact hence, requires no cross-connection. Fig. 6 shows the information which is transmitted to the sender depending upon cross-connections between the (R) relay contact and the transmitting relay windings. Each terminal, its function, and description are described below.

## "CL" TERMINAL

The "CL" (class of call) terminal of each route relay is assigned to the "P" or "S" terminal of one of the (CL0) to (CL6) relays according to the class of call and whether or not the (TW) relay in the sender, should be operated. The sender (TW) relay must be operated when there is a full selector tandem district selector or a distant office selector in the route. The (TW) relay is also operated for operator class of call on which

the trunk normally has reversed battery during trunk test such as permanent signal and vacant code trunks. The (TW) relay is operated on calls from KPA operators to other operators reached through operators trunks directly connected to a panel system 2 wire office multiple. The classes of calls which are shown abbreviated on Fig. 6 are as follows:

PAN Panel direct class.  
 XB Crossbar direct class.  
 PCI Panel call indicator direct class.  
 PCIT Panel call indicator tandem class.  
 FST Full selector tandem class.  
 O-RC Operator-restricted code class (used for substitute routing to special service operator for denied service or a restricted code group, and for overflow routes on all but zero and 3 digit operator's codes, sender awaits five numerals).  
 OPR-T Operator tandem (class 3 digit operator codes routed through panel call indicator tandem or full selector tandem).  
 OPR Operator direct class (special service and 3 digit operator, permanent signal, 3 digit test and vacant codes - sender does not wait for numerals).

#### "CR" TERMINAL

The "CR" terminal of each route relay is assigned to the "P" or "S" terminal of one of the (CR0) to (CR9) relays according to the compensating resistance required and the trunk guard (TG) or (MTG) relay to be used. The sender compensating resistance to be used for fundamental selections with different trunk conductor loops is covered below. Where office selections are skipped the resistance value for office selections is, of course, ineffective and the resistance value for beyond office becomes effective on selections beyond the district. On calls routed through distant office selectors, the resistance of the polarized relay in the distant office selector should be included in the trunk conductor resistance for beyond office selections. Trunk conductor loops for call indicator pulsing should be compensated to a minimum of 900 ohms. Use 900 ohm compensation for local trunks such as special service trunks. Use 900 ohm compensation for all 3 wire office panel selectors, which are used only where the trunk loop is 0 ohms.

#### Distant Office (2 Wire), Repeating Incoming, Battery Cut-off Incoming Panel Selectors

Trunk Conductor Resistance	Sender Compensating Resistance	Office or Incoming Compensating Resistance
0-65	900	600
66-375	900	300
376-686	900	0
687-1000	600	0
1001-1310	300	0
1311-*	0	0

\*Working limit of the circuits used.

#### Ground Cut-off Incoming and Final Panel Selectors and Crossbar Incoming Trunks

Trunk Conductor Resistance	Sender Compensating Resistance	Office or Incoming Compensating Resistance
0-350	900	0
351-660	600	0
661-975	300	0
976-*	0	0

\*Working limit of the circuits used.

Note: In the case of repeating incoming and battery cut-off incoming selectors where compensating resistance in addition to the maximum furnished by the sender is required for beyond office selections and distant office selectors are included in the routing, this supplementary resistance should if practical be provided in the distant office selector circuit, rather than in the incoming selector.

The (MTG) relay is required on all calls over trunk groups to non-repeating ground cut-off panel incoming selectors. These trunk conductor loops are always 1300 ohms or less. Associated with the (MTG) relay as controlled by ground on the "CR5" lead are two additional features:

- Cable discharge circuit before final brush selection which prevents false operation of the sender (STP) relay from the charge on the cable if some time is required for finding an idle final selector.
- Auxiliary path for operating the (O), (FO), (BO) relays through a late make contact of (IA) relay. This condition is needed when working certain incomings which have only one sequence switch position for reverse battery which may not provide sufficient time for operating the (STP) relay.

#### "OB" TERMINAL

The "OB" terminal of each route relay is assigned to the "P" or "S" terminal of one of the (OB0) to (OB9) relays according to the office brush selection and station delay required. When office selections are skipped, the assignment in this group should be confined to the (OB0) or (OB5) relay to provide station delay. The station delay classifications are as follows:

- Station delay on all numbers. Required on calls to jack - per - line (party letters) manual offices having numbers greater than 9999.
- Station delay only on calls having number starting ten. Required on calls to jack-per-station (no party letters) manual offices having numbers greater than 9999.
- No station delay. Required on calls to jack-per-station (no party letters) manual offices having no numbers greater than

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9999 and panel and crossbar offices. It is also used for uniformity on operator classes of calls.

(d) Station delay on all calls. Required on calls to jack-per-line (party letters) manual offices having no numbers greater than 9999.

### "OG" TERMINAL

The "OG" terminal of each route relay is assigned to the "P" or "S" terminal of one of the (OG0) to (OG4) relays according to the office group selection required or to the "S" terminal of the (OG5) relay if office selections are to be skipped.

### "SB" TERMINAL

The "SB" terminal of each route relay is assigned to the "P" or "S" terminal of one of the (SB0) to (SB9) relays according to the second office brush selection and the compensation required for making second office selections. When second office selections are skipped, the assignment in this group should be confined to the (SB0) to (SB5) relays.

Note: If no calls are routed through two office selectors the (SB-) and (SG-), etc., relays may not be provided, in which case the "SB" and "SG" terminals are not cross connected.

### "SG" TERMINAL

The "SG" terminal of each route relay is assigned to the "P" or "S" terminal of one of the (SG0) to (SG4) relays according to the second office group selection required or to the "S" terminal of the (SG5) relay if second office selections are skipped. See note above.

## TRANSMITTING CR INFORMATION

Fig. 8 shows how the compensating resistance information is transmitted from the marker and recorded in the sender. There is a standing test on all five transmitting leads for false grounds through the back contacts of the (CO3) relay. If there is a false ground the (XT1) relay operates, bringing the originating trouble indicator to record the trouble.

One and only one of the windings of the (CRO) to (CR9) relays will be grounded through a cross-connection by an operated (R) relay. If two windings were grounded, the (XCR) relay would operate, bringing in the trouble indicator.

Assuming any one of the (CR-) relays operated, it will be noted that any "CR1" to "CR5" leads to be used is transferred from the (XT1) relay standing test of the winding of the (CRA), (CRB), or (CRC) relay, thus making a continuity check of the lead used. The (CRP) and (CRS) relays are used in checking the continuity of the

primary and secondary windings of the (CR-) relays and in combination with the (CRA), (CRB), and (CRC) relay to check that the proper "CR1" to "CR5" leads are used on the call, the proper operation of the (CRP), (CRS), (CRA), (CRB), and (CRC) relays partially closes the circuit for operating the transmission check (TK) relay.

The (CR-) relay in the sender operates in series with the (CRA), (CRB), or (CRC) relay. The (CR-) relays in the sender do not lock at the time the decoder start (DST) relay is operated but to the decoder release (DRI) relay which does not operate until the marker is sure there is an available trunk.

The remainder of the information transmitted to the sender is transmitted over five other groups of leads in a manner similar to that shown on Fig. 8. Each group has a similar group of checking relays, (-P), (-S), (-A), (-B) and (-C), the various - depending upon the group of leads "CL", "CR", etc. (see headings for Fig. 6). When the checking relays in all six groups have functioned properly, the (TK) relays operate indicating to the marker that information has been transmitted to the sender and will be recorded when a locking ground is provided for the register relays in the sender.

### "ST" TERMINAL

The "ST" terminal of each (R) relay is assigned to the "ST" (start) terminal corresponding to the pair of office frames upon which are located the trunks for the route. If there is more than one sub-group of trunks assigned to the (R) relay, the "ST" terminal is cross connected through a "GC-ST" terminal and the corresponding two "GP-ST" terminals or the three, four, six, or twelve "G-ST" terminals depending upon whether there are two, three, four, six, or twelve sub-groups of trunks assigned to the one route relay (see Fig. 9). If there are three, four, five, seven, or thirteen sub-groups of trunks in the one route then one sub-group will be assigned to one route relay in ground supply group 2 or 4, the remainder of the sub-groups will be assigned to one other route relay located in ground supply group 1 or 3 as mentioned in the previous sentence.

### "TL" TERMINAL

The "TL" terminal of each (R) relay is assigned to the "TL" (trunk level) terminal assigned for the group of trunks if there is only one sub-group in the trunk group, otherwise similar to "ST" terminals.

The terminals "TLO" to "TL9" represent the various horizontal levels on the regular office secondary switches to which the trunks are connected. The level of the trunk on the left half of the switch agrees with the TL number on the regular frame. The trunk on the right half of the regular switch is either one horizontal higher or lower than the TL number as indicated in the

following table. TL10 to TL14 always indicate the trunk levels on office build out secondary switches. These trunks are always on a non-split basis; hence only five levels are needed.

Office Link Sec. Switches		
Trunk Level	Horizontal Level	
Cross Connected	Left Half	Right Half
0	0	1
1*	1	0
2	2	3
3*	3	2
4	4	5
5*	5	4
6	6	7
7*	7	6
8	8	9
9*	9	8
10	0	1
11	2	3
12	4	5
13	6	7
14	8	9

\*Not used if trunks are on a non-split basis.

#### "GS" AND "GE" TERMINAL

The "GS" and "GE" terminals of each (R) relay are assigned to the "GS" (group start) and "GE" (group end) terminals assigned for the group of trunks, if there is only one sub-group in the trunk group; otherwise they follow as indicated for "ST" terminal. The "GS" terminals have additional designations shown in columns 1 and 3 of the table in next paragraph and "GE" terminals are designated as shown in columns 2 and 4.

The trunk group always starts with a trunk on the even office link frame on any point indicated in columns 1 or 3 and it always ends with a trunk on the odd office link frame or on any point in columns 2 or 4, as follows:

1	2	3	4
<u>GS</u>	<u>GE</u>	<u>GS</u>	<u>GE</u>
EL0	OL0	ER1	OR1
EL2	OL2	ER3	OR3
EL4	OL4	ER5	OR5
EL6	OL6	ER7	OR7
EL8	OL8	ER9	OR9
ER0	OR0	EL1	OL1
ER2	OR2	EL3	OL3
ER4	OR4	EL5	OL5
ER6	OR6	EL7	OL7
ER8	OR8	EL9	OL9

If there are an odd number of trunks in a group, it is necessary to make at least one trunk terminal busy. It is desirable to have a few spare terminals in each trunk group containing less than forty trunks to allow for growth. If there are forty trunks in the group it may start at any point indicated above and will, therefore, end on the preceding point considering the trunks in order reading from left to right and from the top down also considering that the last line is followed by the first line. This same order, or the reverse order is used by the marker in making

trunk test so that the trunks located in a particular group are those on the TL cross connected and between the GS and GE cross-connections as indicated in the chart and remembering that the horizontal level of the left and right trunks are as indicated in the chart.

#### "SP" TERMINAL

The "SP" terminal of each (R) relay except (R) relays in GSG5 is assigned to one of the following terminals: "SPA", "SPB", "OG5P", "OG5S", "TWA" or "TWB". The "OG5P", or "OG5S", terminal is used on the original (R) relay and "TWA" or "TWB" on the alternate (R) relay when there is an alternate route through a panel office selector and when there are no office selections on the original route, otherwise use "SPA" and "SPB" terminals. The "OG5P", "TWA", "SPA" terminals are used when there are two and only two sub-groups in the group of trunks.

#### "RA" TERMINAL

The "RA" terminal of each (R) relay is assigned the "RC" terminal of an (R) relay in a higher numbered group supply group which is the next route choice for the (R) relay under consideration (see Fig. 1). If the (R) relay being cross connected is in GSG1, its "RA" terminal is connected to "RC" terminal of the associated alternate route (R) relay if there are less than 81 trunks in the original route. If there are over eighty trunks in the original route (GSG1), the "RA" terminal is cross connected to the "RC" terminal of the common sub-group (R) relay in GSG2 whose "RA" terminal in turn is cross connected to the "RC" terminal of the alternate route (R) relay in GSG3, it is usually cross connected through a "J INTO" terminal since one alternate route usually will serve for a number of codes. The "RA" terminals for (R) relays in GSG3 cross connect to the "RC" terminal of the associated (R) relay in GSG4 if there are over eighty trunks in the trunk group. The "RA" terminal of the (R) relay in GSG4 or in GSG3 if there are less than 81 trunks in the group, should be cross connected. The "RA" and "SP" terminals need not be cross connected for the overflow or permanent signal (R) relays in GSG5.

The "PC" (peg count) and "OF" (overflow) terminals of each route relay may be assigned to traffic registers. In a great many cases, one trunk group will be used for a number of codes, hence the "PC" and "OF" terminals of the associated (R) relays will connect to one (PC) and one (OF) register respectively. If there are two route relays (three or more sub-groups in the one trunk group) for any code or alternate route so that there is an (R) relay in each of ground supply groups 1 and 2 or 3 and 4, cross connect the "PC" terminal of the (R) relay in ground supply group 1 or 3 and never in ground supply group 2 or 4. Cross connect the "OF" terminal of the (R) relay in ground supply group 2 or 4 and not to the (R) relay in ground supply group 1 or 3 if an (R) relay is provided in ground supply group 2 or 4.

The cross-connection information for cross connecting the various terminals of the (R) relays is shown in a condensed form on Fig. 7.

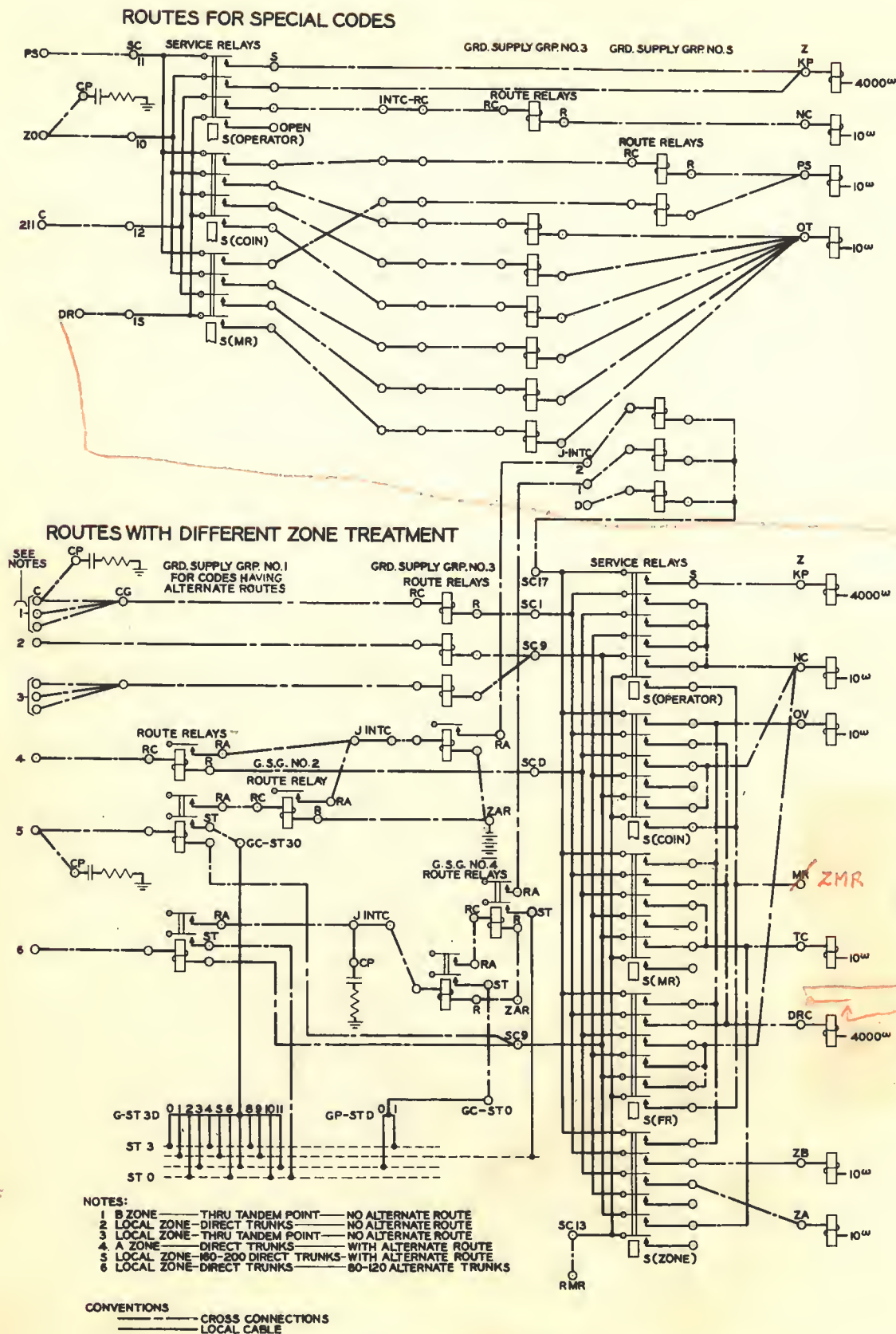


Fig. 1 - Originating Marker - Route Relay Cross-connections

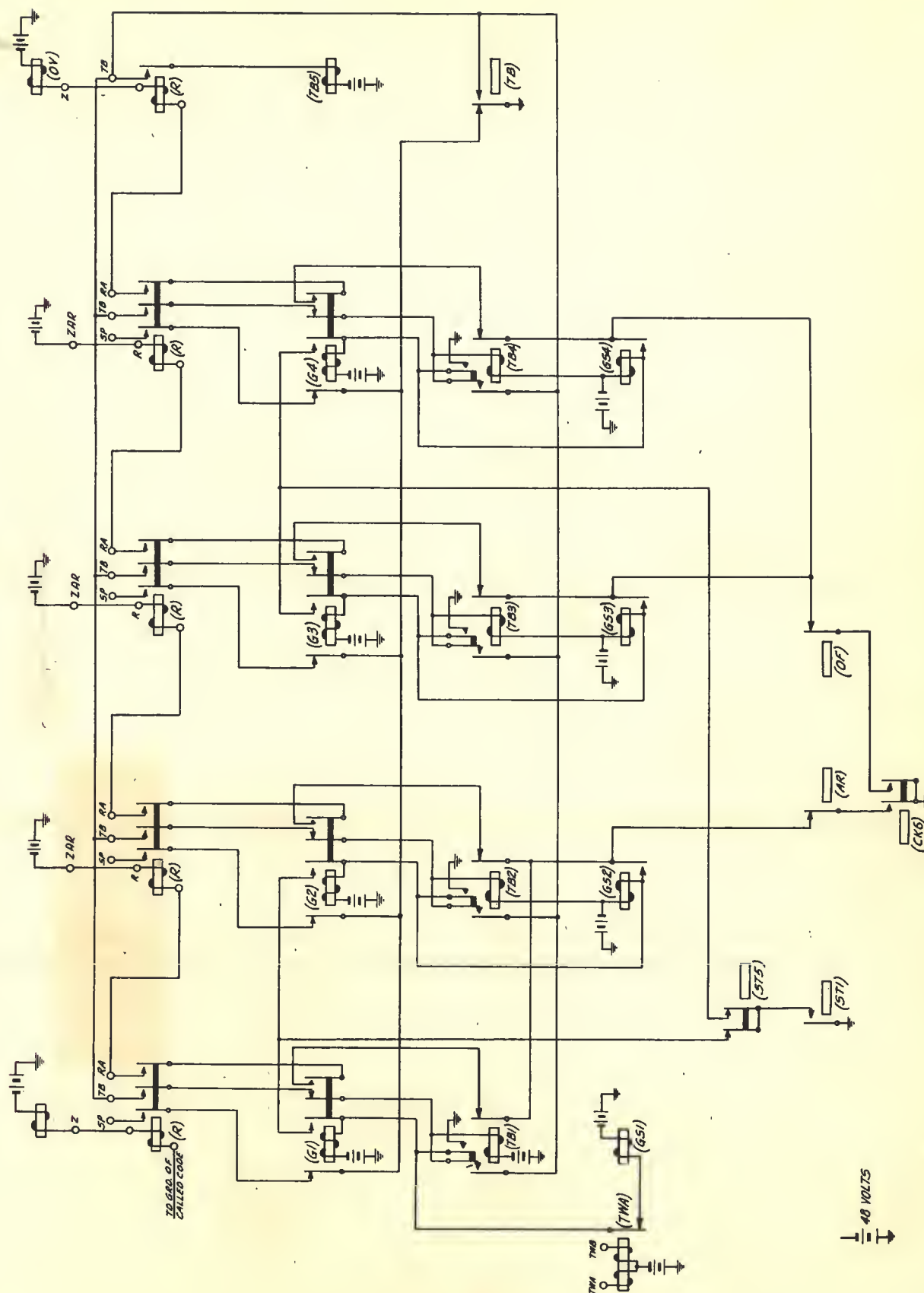
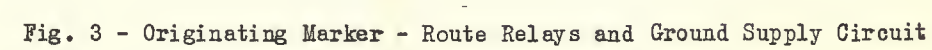


Fig. 2 - Originating Marker Ground Supply Relays







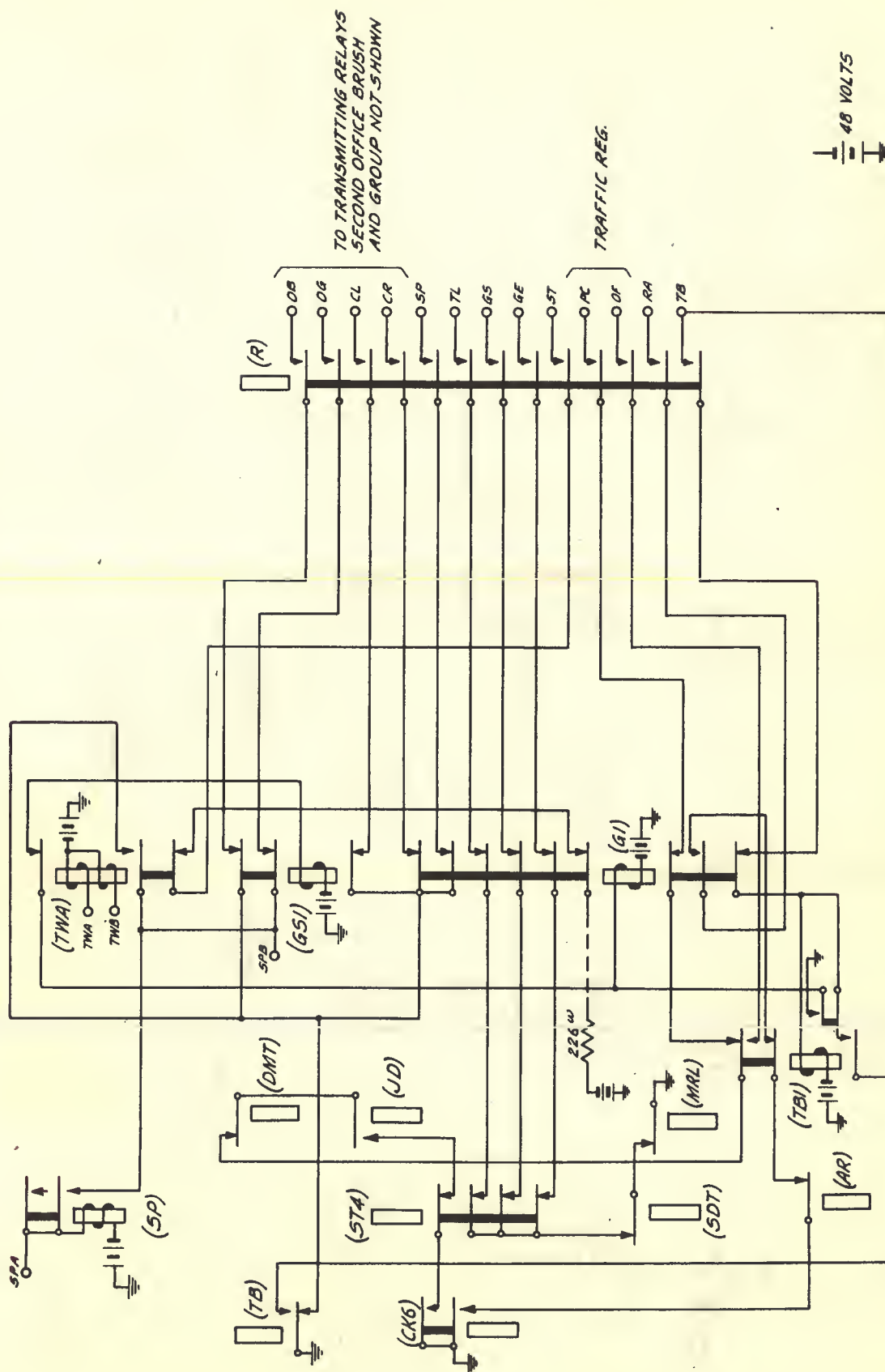


Fig. 4 - Originating Marker - Leads from Ground Supply Relays to Route Relays

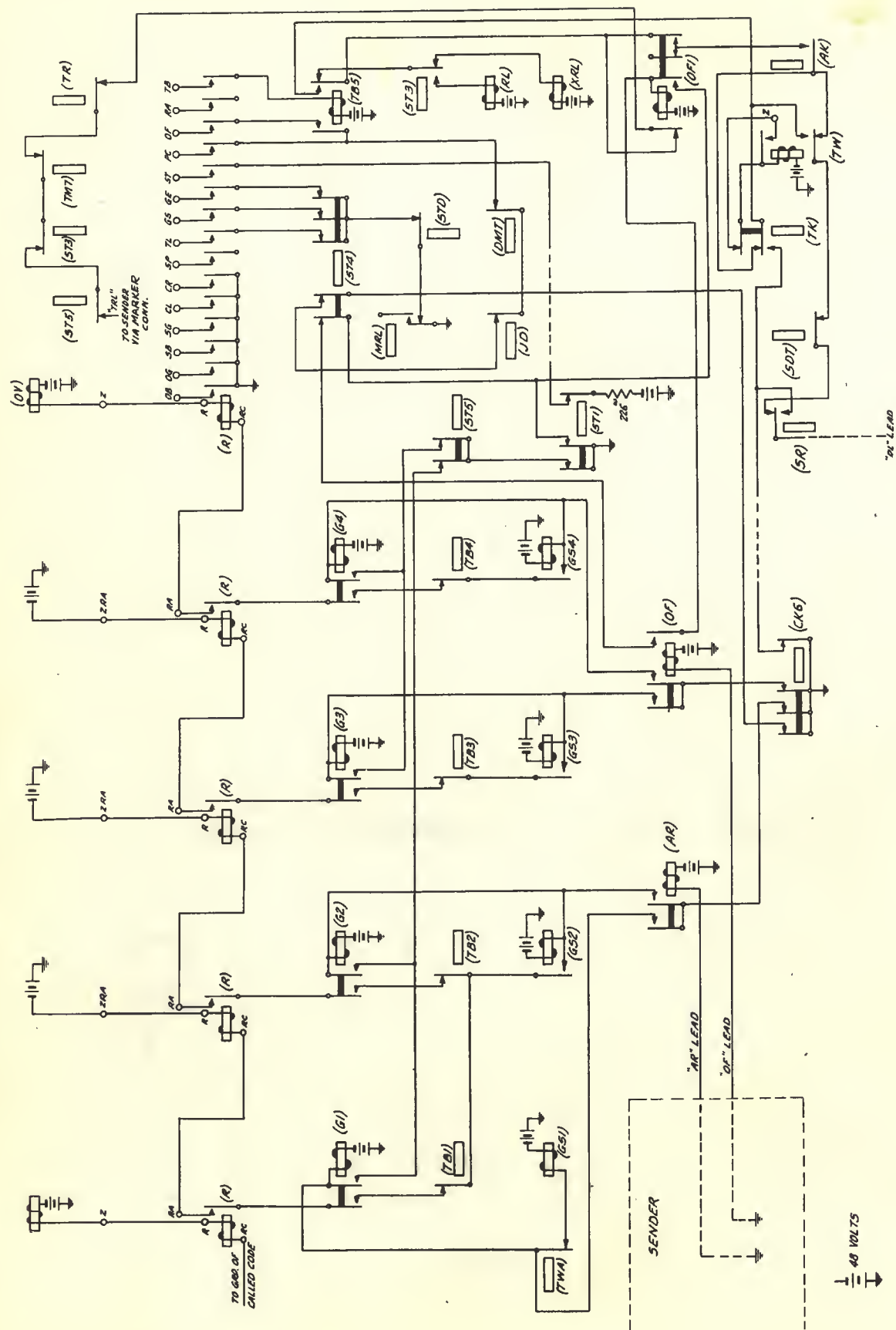


Fig. 5 - Originating Marker - Recording Overflow Indication

[illegible]

Fig. 6 - Selections Controlled By Transmitting Relay Group

Punching	Original Route When Alternate Route is Provided			Alternate Route if Provided			Original Route if Alt. Route is Not Provided			Overflow or Perm. Sig.		
	Notes	GSGL	Notes	GSGL	Notes	GSGL	Notes	GSGL	Notes	GSGL	Notes	GSGL
RC	1,3,10											
	1,3											
	1,4											
R	2,4,5	6,7,8,9	C	8,9	RA-GSG1	6,7,8,9	S (S relay Contact) C (Code Point) RA-GSG1 or RA-GSG2	8,9 8,9 8,9	RA-GSG3 RA-GSG3 RA-GSG3	6,7,8,9	S	RA-GSG3 or RA-GSG4
	1,3,10											
	1,3											
RA	2,4,5	6,7,8,9	SC	8,9	ZAR	6,7,8,9	ZOT, ZKP, ZMC SC- ZAR	8,9 8,9 8,9	ZAR ZAR ZAR	6,7,8,9	ZPS ZOV, ZKP ZOV, ZKP	
	1,3											
	1,3											
OB	2,4,5	6,7	RC-GSG3	8,9	RC-GSG3	6,7,8,9	RC-GSG5 RC-GSG4	8,9	RC-GSG5		None	
	1,2,3,4	6,7,8,9										
	1,2,3,4	6,7,8,9										
OG	1,2,3,4	6,7,8,9	Cross Connect to corresponding relays as required	8,9	Same Cross-connection as for GSG1	6,7,8,9	Cross Connect to corresponding transmitting relays as required	8,9	Same Cross-connection as for GSG3	(6,7,8,9) (6,8,9) (7)	0B5 Pri. 0G5 Sec. 0G5 Pri.	
	1,2,3,4	6,7,8,9										
	1,2,3,4	6,7,8,9										
SB	1,2,3,4	6,7,8,9										
	1,2,3,4	6,7,8,9										
	1,2,3,4	6,7,8,9										
CL	1,2,3,4,5	6,7,8,9										
	1,2,3,4,5	6,7,8,9										
	1,2,3,4,5	6,7,8,9										
CR	1,2,3,4,5	6,7,8,9										
	1,2,3,4,5	6,7,8,9										
	1,2,3,4,5	6,7,8,9										
OB	5	6,7,8,9	Cross Connect to corresponding relays as required for alternate route	8,9	Same Cross-connections as for GSG1	6,7,8,9		8,9	None		Same as above	
	5	6,7,8,9										
	5	6,7,8,9										
SB	5	6,7,8,9										
	5	6,7,8,9										
	5	6,7,8,9										
SG	5	6,7,8,9										
	5	6,7,8,9										
	5	6,7,8,9										
CL	5	6,7,8,9										
	5	6,7,8,9										
	5	6,7,8,9										
TL	1,2,3,4,5	6	TL, GS, GE, ST (CC- contacts (of GP relay GC- or G- relay	6	TL, GS, GE, ST GC- Contact or GP relay GC of G- relay	6	TL, GS, GE, ST GC- Contact or GP relay GC of G- relay	6	TL, GS, GE, ST GC- Contact or GP relay GC of G- relay	6	TL, GS, GE, ST GC- Contact or GP relay GC of G- relay	TL, GS, GE, ST GC- Contact or GP relay GC of G- relay
	1,2,3,4,5	7		7		7		7		7		
	1,2,3,4,5	8		8		8		8		8		
GE	1,2,3,4,5	9		9		9		9		9		
	1,2,3,4,5	9		9		9		9		9		
	1,2,3,4,5	9		9		9		9		9		
ST	1,2,3,4,5	9		9		9		9		9		
	1,2,3,4,5	9		9		9		9		9		
	1,2,3,4,5	9		9		9		9		9		
SP	1,2,3,4	6,8,9	SPB	8,9	SPB	6,8,9	SPB	8,9	SPB		None	
	1,2,3,4	7	SPA	8,9	SPA	7	SPA	8,9	SPA			
	1,2,3,4	7	OG5 Sec.	8,9	OG5 Sec.	7	TWB	8,9	TWB			
5	5	6,8,9										
	5	6,8,9										
	5	6,8,9										

## NOTES

- Code having no alternate route.
- Code having both an original route and an alternate route.
- Code having more than one trunk group depending upon class of service. These will probably never have an alternate route, however, it is not prohibited by marker.
- Code having only one trunk group with various charge conditions depending upon class of service (usual code requirement).
- Code having original route through no office selectors and with alternate route common to a number of codes thru one or two office selectors.
- Trunk group have 40 or less trunks (one sub-group) one route relay in GSG1, GSG3, or GSG5 none in GSG2 or GSG4.
- Trunk group having 41 to 80 trunks (two sub-groups) one route relay in GSG1, GSG3, or GSG5 none in GSG2 or GSG4.
- Trunk group having 81 to 120 trunks (three sub-groups) two route relays one each in GSG1 and GSG2 or GSG3 and GSG4 or one in GSG5 (maximum 80 trunks).
- Trunk group having 121 to 520 trunks (4 to 13 sub-groups) two route relays one each in GSG1 and GSG2, or GSG3 and GSG4 or one in GSG5 (maximum 480 trunks no common sub-group.)
- The permanent signal code route relay appears in (group supply group) GSG5 only.
- For permanent signal cross connect CL to CL6 Sec. There will be three overflow route relays cross connect CL one to CL6 Sec. the second to CL4 Sec. the third to CL4 with its associated OB punching cross connected to OB Sec. instead of OB5 Pri.

Fig. 7 - Originating Marker Cross-Connections Of Route Relay Punchings

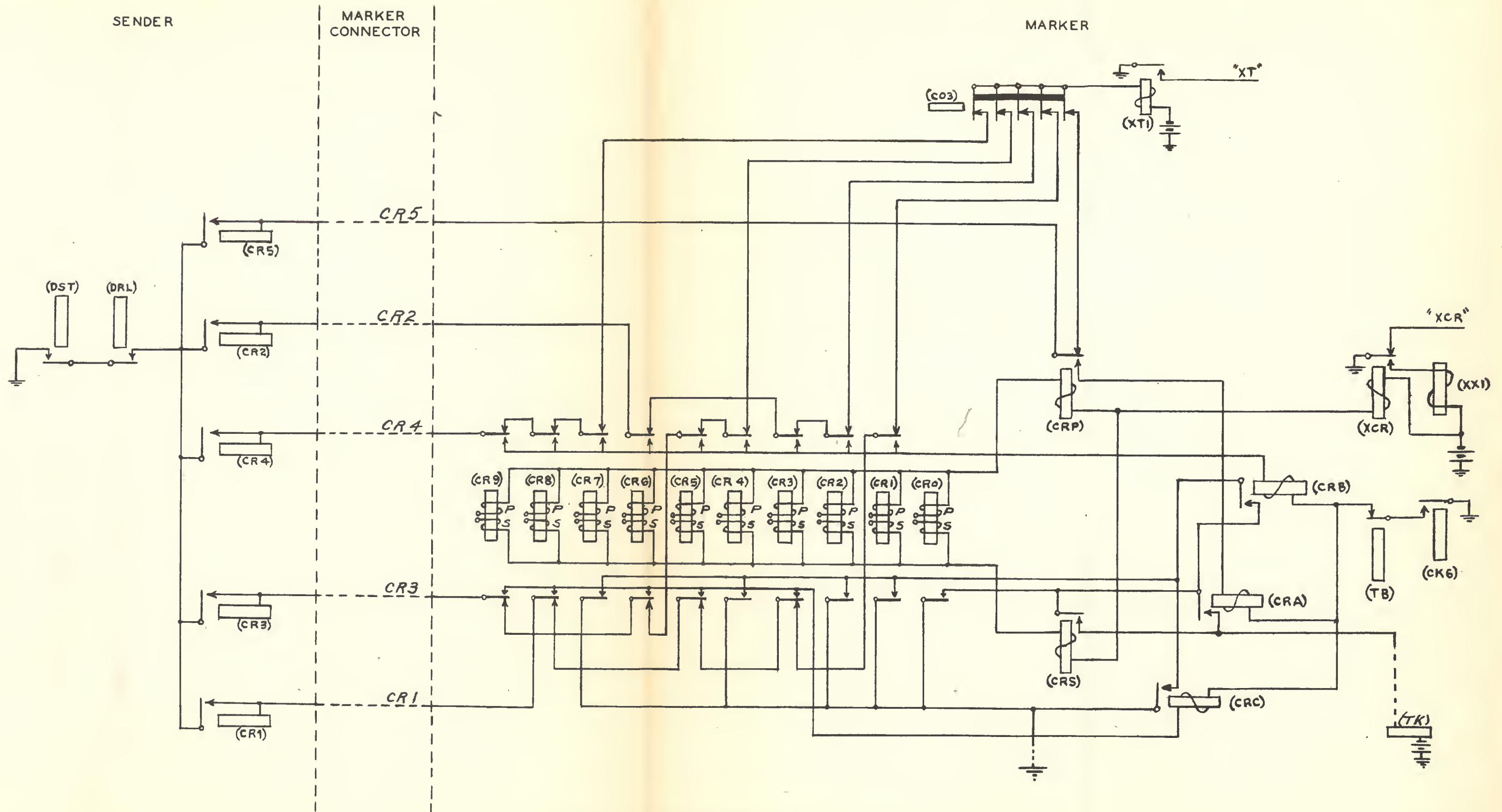


Fig. 8 - Originating Marker - Transmitting Compensating Resistance Information to Sender



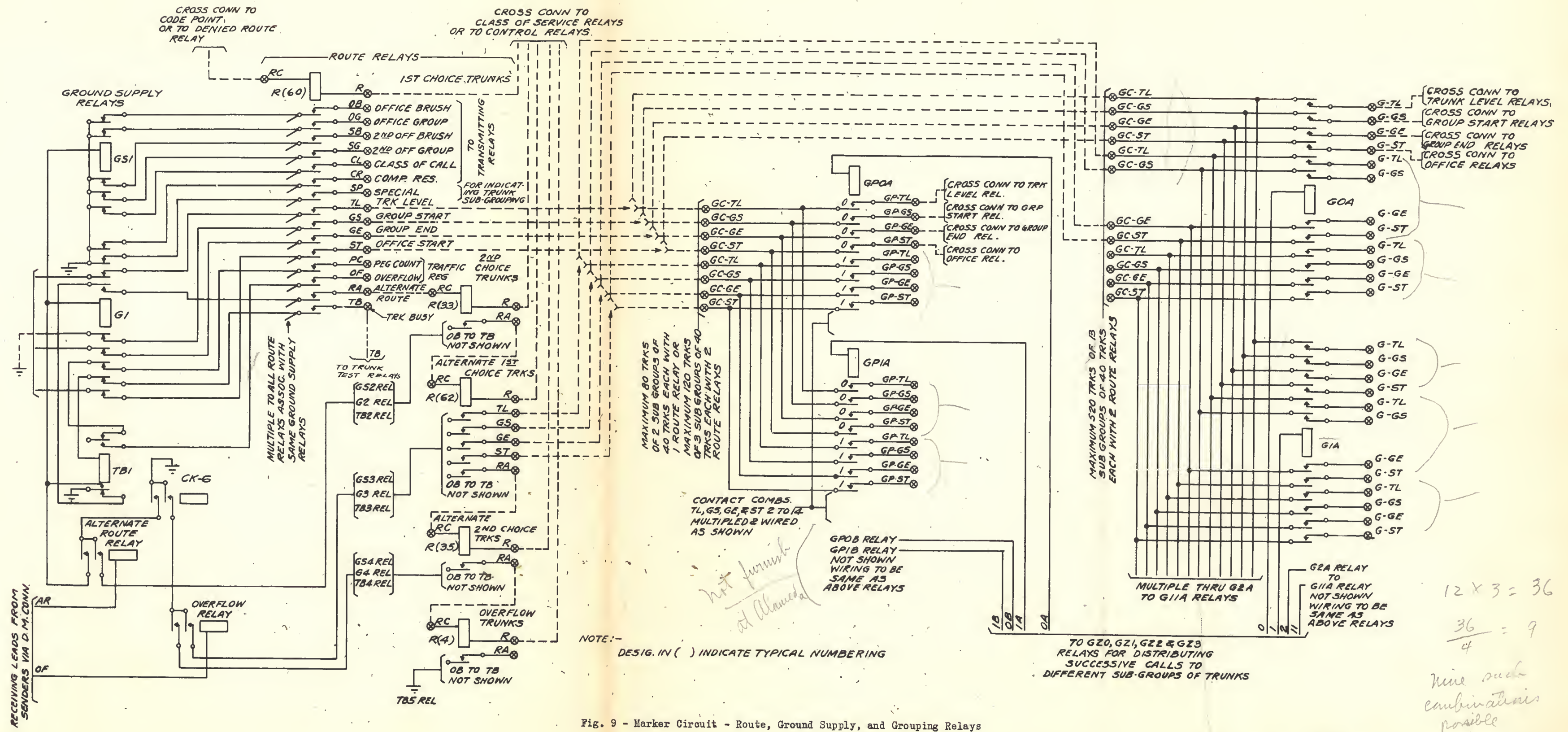




Fig. 10 - Originating Larker Cross-Connection - Service Relays

[illegible]



## CHAPTER 18 - OUTGOING TRUNK TEST AND SELECTION

When the code information has been received by the originating marker it is translated by the various cross-connections to, and the operation of, the associated route relay. The trunks to the called office are then tested by the originating marker. To do this the marker must seize the proper pair of office link frames and obtain access to the sleeve leads of the trunks to the desired office.

### SELECTING A PAIR OF OFFICE FRAMES

The pair of office frames is picked by placing resistance battery, under control of the operated (R) route relay, on the office "ST" lead, causing the (MP) relay of the circuit associated with the marker to operate if not in use as shown on Fig. 1 and as discussed in Chapter 13. Relay (MP) operated causes relays (MCA) of even office frame and (MCA) of odd office frame to operate. Relay (MCA) of the office operated grounds the "OK" lead. This operates the particular frame relay (0-0) to (0-9) corresponding to the pair of office frames selected. The operation of the (0-) relays checks that the proper office link frames were seized and later assist in operating the proper junctor connector (JC) relays in the district link frames.

### SELECTION OF DISTRICT FRAME ORIGINATING THE CALL

The operation of the office (MP) relay also places resistance battery on the "SB" lead through the operated (DF-) relay corresponding to the district frame used by the originating call, to operate the (MP) relay in the district link and connector circuit if this frame is not busy on another call (see Fig. 1). With this relay operated, the (MCA) and (MCB) relays of the district link connector are operated, also ground is placed on the "DK" lead to the marker which goes through the marker and leaves as the "DC" lead, passing through the marker connector, originating sender, and sender link to the district junctor to operate relay (F).

In case the desired district link frame is busy with another marker at the time this marker attempts to seize it, this marker will proceed with trunk test.

### SELECTION OF PRIMARY SWITCH IN DISTRICT LINK

With district junctor (F) frame relay operated, it operates the associated selecting magnet on a primary switch of the district link and connector circuit, also the (LC-) relay associated with that primary switch. The district junctor

(F) relay also closes through the "DC" lead to the make contacts of the operated (LC-), which continues to a make contact of the (MCA) relay to return to the marker as the "AK" lead, operating (AK) and (AK1) relays.

When the (SR) relay operates, as described later, a circuit is closed over lead "AK" to hold the district junctor (F) relay operated until the marker has completed its functions. The marker connector will be released before the marker has established the connection through the district and office links.

The operation of the (AK) and (AK1) relays, indicates to the marker that the (LC-) relay is operated, hence the district "LS" leads are closed through ready for channel test, and also that the district is held through the district link and, therefore, the marker connector may be released as soon as the trunk has been selected.

### OPERATING THE TRUNK LEVEL RELAYS

When a route (R) relay operates, ground is placed on the "TL" lead, operating one of the fourteen (TL-) relays as indicated on Fig. 2. If more than one "TL" lead is grounded the marginal relay (XTL) would operate, bringing in a trouble condition. If more than one "TL-" lead to an office frame were grounded the (XTLL-3) relays would indicate the trouble condition.

With relay (TL-0) operated, ground is placed on leads "TLO" even and odd to the pair of office frames that were previously seized and have their (MCA) relays operated. Leads "TLO" even and odd cause the (TLO) relay in both frames to operate. Relay (TL) of the office is wired in parallel with (TR1) relay which would be another trunk level as described in Chapter 7 and indicated in Chapter 7, Fig. 3 and Chapter 18, Fig. 2.

The trunk level is the level at which the trunks appear on the office link secondary switches. Relay (TL) indicates the level on the left half of the secondary switch and (TR) relay indicates the level on the right half of the secondary switch.

### TRUNK MULTIPLE SPLIT OR NON-SPLIT

The (TL) and (TR) relays also indicate to the marker whether the trunk group is split or non-split. In the case of a split group the "SP" punchings on the (TL-) and (TR) relays are cross-connected shown by "X" wiring on Fig. 2, grounding lead "SP" to the marker. If the trunk group is non-split, the "NS" punchings of these relays are cross connected, shown as "Y" wiring, grounding lead "NS". If one office frame for a particular level is split, its mate frame must also be split and the same holds true for non-split levels.

## OUTGOING TRUNK SELECTION

Assuming the trunk groups are non-split with the (TL) and (TR) relays of both office frames operated, the "NS" leads, even and odd, would be grounded, causing relays (NSE) and (NSO) of the marker to operate. With both of these relays operated indicating that the sleeves of the trunks on both frames are closed for testing, ground is removed from the negative side of the secondary winding of relay (PT). This has been holding the (PT) relay non-operated. It will now operate after the condenser has charged. Time for testing all trunks in the group of forty is allowed by the slow operate of the (PT) relay; further details follow.

In the event that only one of the (NS) relays should operate, relay (PT) could not operate and would cause the marker to time out, provided the (AR) relay had not been operated. The same condition applies to the (SP) relays.

### ONE OF THE PAIR OF OFFICE FRAMES AVAILABLE

When the (AR) relay is operated, indicating an alternate route call the (BF) relay is operated which in turn operates (AR1) and (AR2) relays which lock. Under this condition, if either of the pair (NSE) or (NSO) relays fails to operate, the (XBO) or (XBE) relay will operate, (XBO) operating for an odd office frame failure to ground the "NS" lead and (XBE) for an even office frame failure. The same is true for a split condition. With either (XBO) or (XBE) operated, the slow release (BF) relay releases, operating relay (BO) if (XBO) is operated, or operating (BE) if (XBE) is operated.

With relay (BO) operated, it grounds the "T-" leads for the odd office frame trunks giving the indication that these trunks are busy or not available. It also connects together the "NS" leads and the "SP" leads of the two office frames. Relay (BE) performs a similar function for the trunk of the even office frame and treats the "NS" and "SP" leads in a like manner.

With the "NS" or "SP" leads connected together, when one of the leads is grounded it places ground on the mate lead, thus operating both the (NSE) and (NSO) or (SPE) and (SPO) relays, allowing the (PT) relay to operate in the usual manner.

In case one office frame is made busy by the use of a make busy plug, a ground through its mate office link frame (MCA) relay will operate directly the busy even (BE) relay or the (BO) relay depending upon whether the busy frame is even or odd. This applies to either first, second, or third trial. The (BO) or (BE) relay functions as described above.

### CONNECTING TO FORTY "SI" LEADS FROM A PAIR OF OFFICE FRAMES

With the operation of the (MCA), (TL), and (TR) relays of each of the pair of office frames, forty "SI" leads are closed through to the marker to test for busy trunks served by the (TL) and (TR) relays (see Fig. 3).

Although forty trunks are tested to determine whether they are busy or not, the marker only deals with the trunks of the group being used. This group may range from two to forty trunks and is controlled by the "group start" and "group end" (TG-) relays of the marker.

The trunk groups are shown on Fig. 3 as split groups ("X" wiring on Fig. 2). In the case of non-split groups the trunk would extend through the left and right halves of the secondary office switch.

Twenty "SI" leads come from the even office frame designated SI ELO to SI EL9 and SI ERO to SI ER9, likewise twenty "SI" leads come from the odd office frame designated SI OLO to SI OL9 and SI ORO to SI OR9.

When outgoing trunks are used in common with a panel office, the "SI" lead of the outgoing trunk is connected to the "S" lead of the panel trunk, in order to provide a busy indication (ground) if in use at the panel office. A busy condition will also be recognized if the trunk is made busy or in use at the OGT board or automatic incoming test frame.

An outgoing trunk may appear in a panel office multiple and in a crossbar office frame. It may appear in two crossbar office units. However, whenever it appears in a crossbar office unit it will appear only in one place (one horizontal on one office link secondary switch) in a group of office links controlled by one group of markers.

### TRUNK GROUP START AND GROUP END

Although the sleeve leads of forty trunks have been closed through to the marker, the particular trunk group required may be of any number from two to forty. It is, therefore, necessary to determine the first and last trunk of the desired group, in order to choose an idle trunk within the desired group. This information is obtained from the route relay, terminals "GS" and "GE", which indicate the group start and group end points. These terminals are cross connected to the TG- group start and TG- group end according to the size and location of the trunk group.

As stated above, a trunk group or sub-group may consist of any number of trunks from two to forty, except that the arrangement provided in the marker requires an even number of trunks. That is, it cuts in 2, 4, 6, and so on up to 40 trunks. If the particular trunk group or sub-group should consist of an odd number of trunks as 1, 3, 5, 7, etc., up to 39 trunks, then the unused trunk on the office switch is made to appear busy by connecting ground to "SI" terminal corresponding to the unused trunk.

The arrangement in the decoder marker for cutting in a trunk group is a complete circle arrangement and, therefore, the start point may be at any of the twenty start points in the circle. For instance, assuming a trunk group of forty trunks, the start point need not necessarily be at ELO with the end point at OL9, but instead, the start point may be at any other point from

ELO, as for instance, ER1, EL2, ER3, and soon up to EL9. The corresponding end point for a forty trunk group would then be OLO for start point ER1 and OR1 for start point EL2, and OL2 for start point ER3, and so on up to OR8 for start point EL9. The group start (GS) and group end (GE) points are indicated in the table below.

### TRUNK TEST RELAYS

In making trunk test there are forty of each of the (TG-), (P-), (T-) and (K-) relays, one of each for each trunk. Each of these relays has a suffix as shown below. The first letter E or O refers to the even or odd office link frame, the L and R indicates the left or right half of the secondary switch and the number is that of the secondary upon which the associated trunk is located. To completely locate the trunk it is also necessary to know the pair of office frames and the trunk level. The (TG-) relay is used for the group start or group end of the trunk group. The panel (P-) relay is used for testing the trunk for a (ground) busy condition. This relay has a 20,000 ohm winding so as not to interfere with the panel system seizing a trunk which is used in common with a crossbar office. The (P-) relays are not used if the trunks are not multiplied to a panel office. The test (T-) relays are used for testing the trunks when the (P-) relays are omitted. If the (P-) relays are used the (T-) relay operates under control of the (P-) relay. The (K-) relay is used to definitely indicate which trunk has been selected.

The following table shows the order of appearance of these relays in the ten groups. Reading from left to right and down and following tenth line with the first line gives the order of a preference of the trunk on first trial when the call is from an even numbered district frame as indicated by "TR" and "TL" leads at the (AR1) relay on Fig. 4.

	GS	GE	GS	GE
Group	First Relay	Second Relay	Third Relay	Fourth Relay
1	ELO	OLO	ER1	OR1
2	EL2	OL2	ER3	OR3
3	EL4	OL4	ER5	OR5
4	EL6	OL6	ER7	OR7
5	EL8	OL8	ER9	OR9
6	ERO	ORO	EL1	OL1
7	ER2	OR2	EL3	OL3
8	ER4	OR4	EL5	OL5
9	ER6	OR6	EL7	OL7
10	ER8	OR8	EL9	OL9

### TRUNK SELECTED

Any "S1" lead which is grounded (busy) will operate its corresponding (P-) relay which in turn operates the (T-) relay associated with it. Only the (P-) and (T-) relays between the group start and group end points are used on this call, although others may operate. If all the (T-) relays between the group start and group end points should

operate, a circuit is closed to operate the (TB) relay, indicating the trunks of that sub-group are busy.

The (PT) relay was made slow operating in order to allow time for all of the (P) and (T) relays to operate that are associated with grounded "S1" leads. When the (PT) relay finally operates, it closes ground through operated contacts of the (TKE) relay through the operated district frame (DF-) relay, through the normal or operated contacts of the (AR1) relay to an operated (TG-) relay to the (T-) relay, representing the first trunk of the group, thence through the chain contacts of the (T-) and (TG-) relays until it finds the first unoperated (T-) relay. The path is then continued through the back contact of this unoperated (T-) relay to the winding of the associated (K-) relay which operates and locks. The operation of the (K-) determines which trunk is to be used on the call. The (TKE) relay releases, opening the operating circuit to the (K-) relays.

The order of preference of trunks is dependent upon whether the calling district frame has an odd or even number. If the call is not a first trial, the order of preference of trunks is reversed to that of first trial being reversed by the (AR) relay.

### SENDER RELEASE

When the code information has been properly recorded in the decoder, the proper route relay operated, and the information for the proper setting up of the call transmitted to the sender, a path is closed for operating the slow operate (TK) relay. This relay is made slow-operate in order to allow sufficient time for the register relays in the sender to operate before the connection to the sender is broken down as mentioned in Chapter 17.

The path for operating the (TK) relay is opened on calls from an operator's sender where the operator keys a blank code or a code that should not be routed over the particular type of trunk that she has plugged into. In these cases, the (KP) relay is operated in series with the route relay and in turn operates the (KP1) relay. The "RO" lead to the "A" sender is also grounded. This causes the operation of a relay in the sender which in turn causes a lamp at the "A" operator's position to flash as a signal that something is wrong.

When the (TK) relay has operated in the case of a call from an "A" operator's sender that is routed over a direct trunk through a 2 wire office selector and on sender test circuit calls, connection is not made to a district frame. In these cases ground is connected directly to the "RL" lead through the marker connector to the sender.

For all types of calls, except those just mentioned, when the (TK) relay has operated, and with the district frame connected as indicated by the operation of the (AK) and (AK1) relays and when a trunk has been found and the (TKE) relay has been released, then a path is closed for operating the (SR) relay. The (SR) relay, in addi-

## OUTGOING TRUNK SELECTION

tion to furnishing locking ground for numerous relays that would otherwise release when the marker connector releases, also grounds the "RL" lead to the sender.

When the "RL" lead to the sender is grounded the (DRL) relay of the sender operates, which removes battery from the start lead to the marker connector circuit which releases, breaking all connections between the sender and the marker through the marker connector. With relay (SR) operated, the district and district link and connector circuit is locked to the marker over leads "DK" and "AK".

Opening the leads through the marker connector releases all the (A), (B), (C), (D), (F), (AR), (OF), (TP), (TNO-4), (H), and (S-) relays that are operated. The route relay or relays and the transmission relays are also released.

Among the leads broken by the marker connector is the "CKG" lead. This releases the (CK4), (CK5), and (CK6) relays. The (CK6) relay opens the ground that was connected to the "RL" lead, so that in case the portion of the marker is immediately seized again, the "RL" lead will not be

grounded and give that sender a premature release signal. With the (CK6) relay released, the ground that is holding the (ST1) and (ST2) relays is extended to the winding of the (ST3) relay which now operates. The (ST5) relay operates, opening the "DK", "RL", and "TRL" leads which are opened on the (ST3) relays. It is necessary, however, to open them also on the (ST5) relay to prevent the possible false closure of ground to these leads, should the (CK6) relay be again operated due to another call in the decoder stage, and should the (ST3) relay release before the (ST1) relay, on the release of the marker at the completion of a call. The (ST5) relay opens the operating and holding ground to the zone and charge relays. These relays are held, however, over the "ZK" lead to the district link and connector circuit. The (CK6) relay also releases the ground supply group relays (GS1-4) and (G1-4) that are operated. The marker is now free to be seized for use by another sender and the decoder function may take place up to and including the operation of a route relay, even though the marker is still functioning in setting up the connection through the district and office junctors from the previous call. This arrangement is made to reduce the marker holding time.

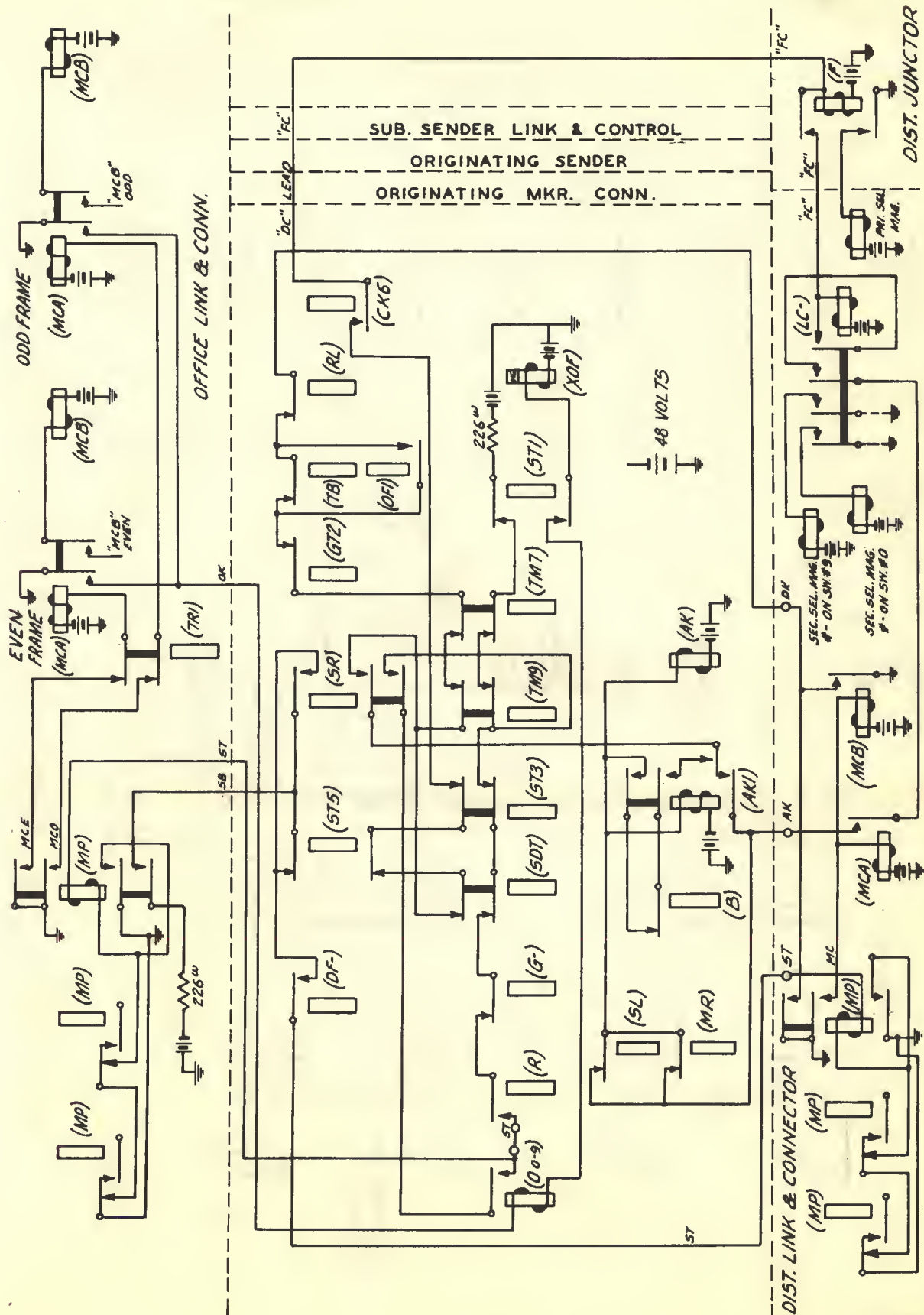


Fig. 1 - Originating Marker - Associating the Office Link and Connector With the District Link and Connector Which Serves the Selected District Junctor

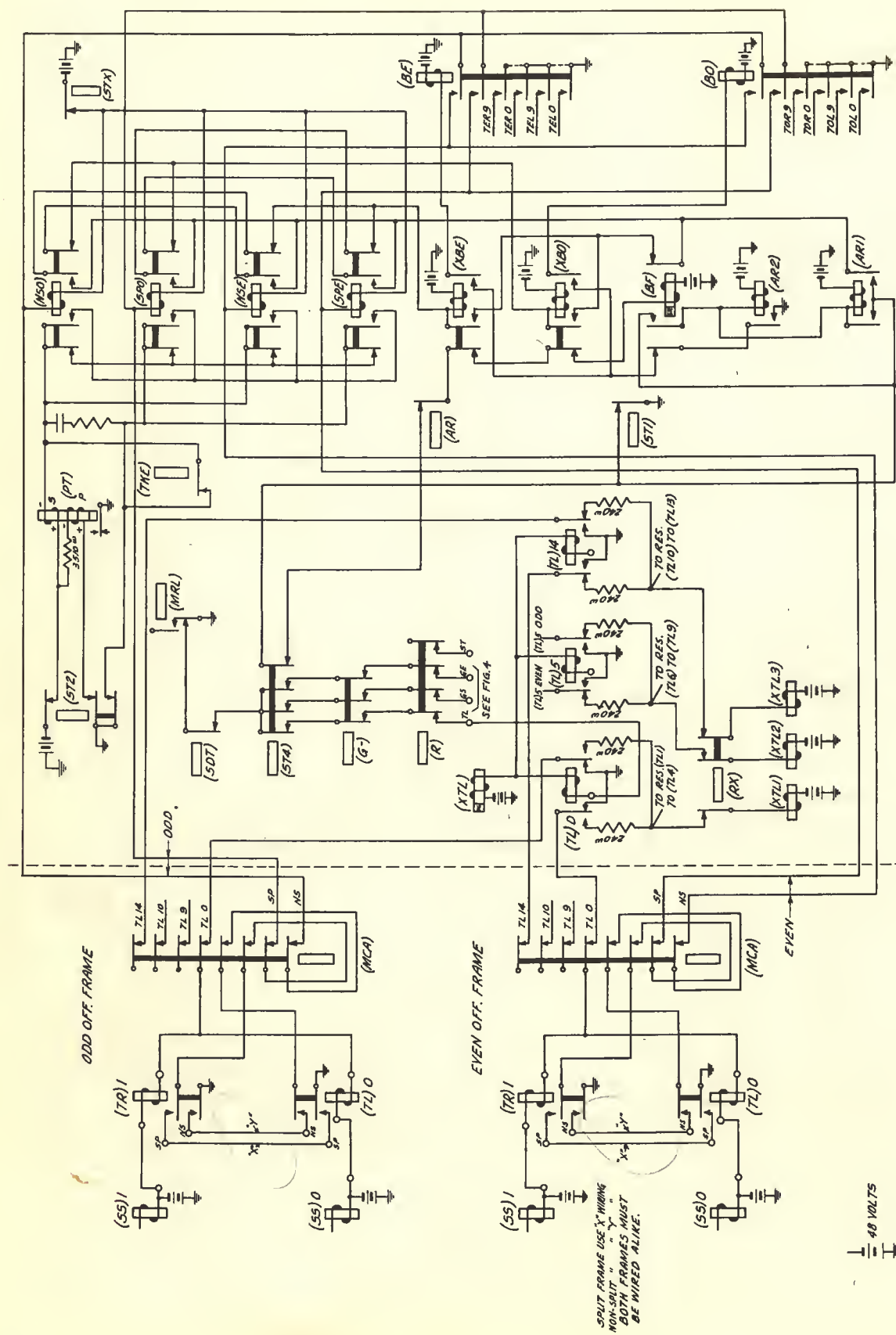


Fig. 2 - Originating Marker - Operating the Trunk Level Relays, Indicating Split or Non-Split Trunks and Indicating that Both Even and Odd Office Frames are Prepared to Have Trunks Tested

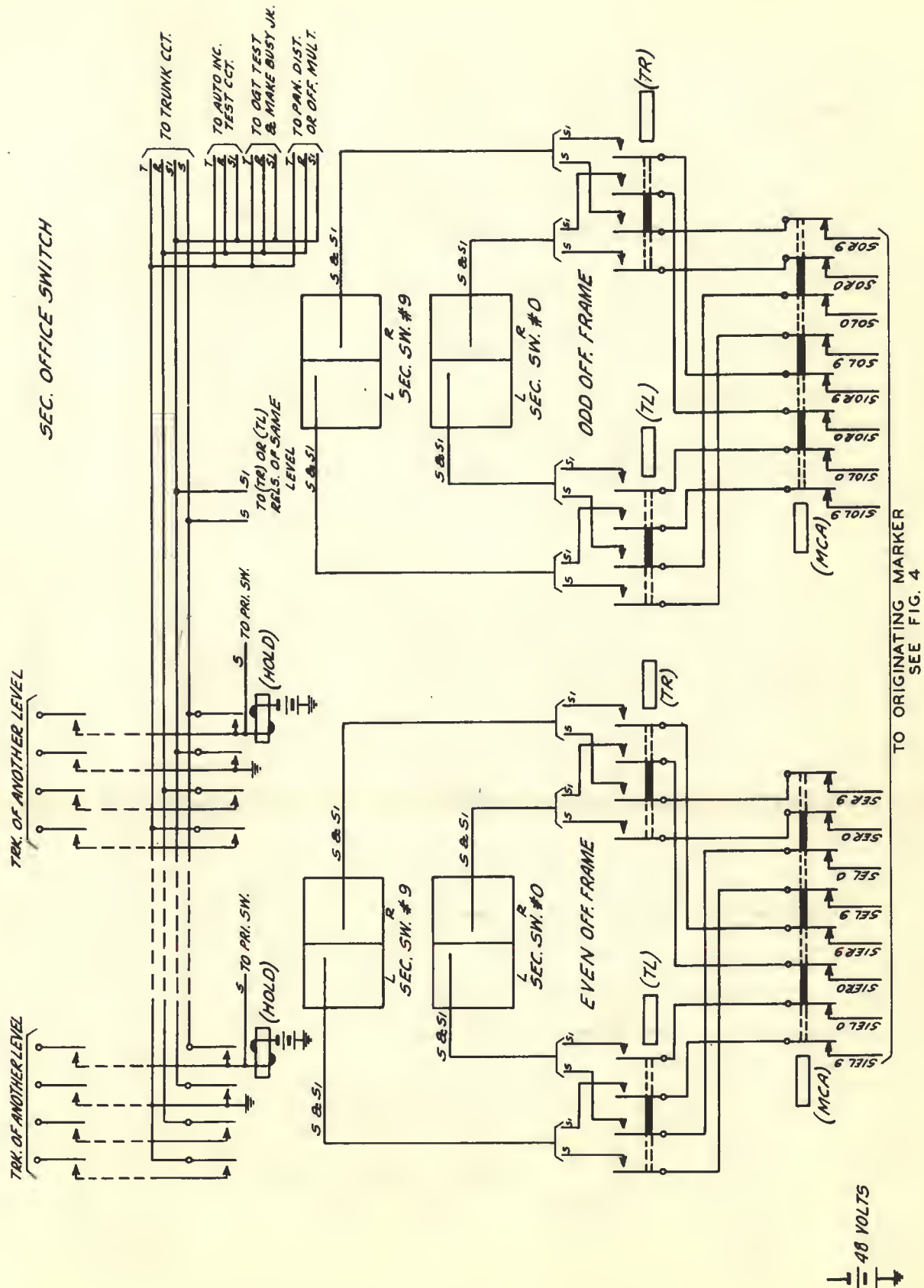


Fig. 3 - Originating Marker - Connecting 40 "S" and "S1" Leads From Associated Office Frames to the Marker to Test for Busy Trunks

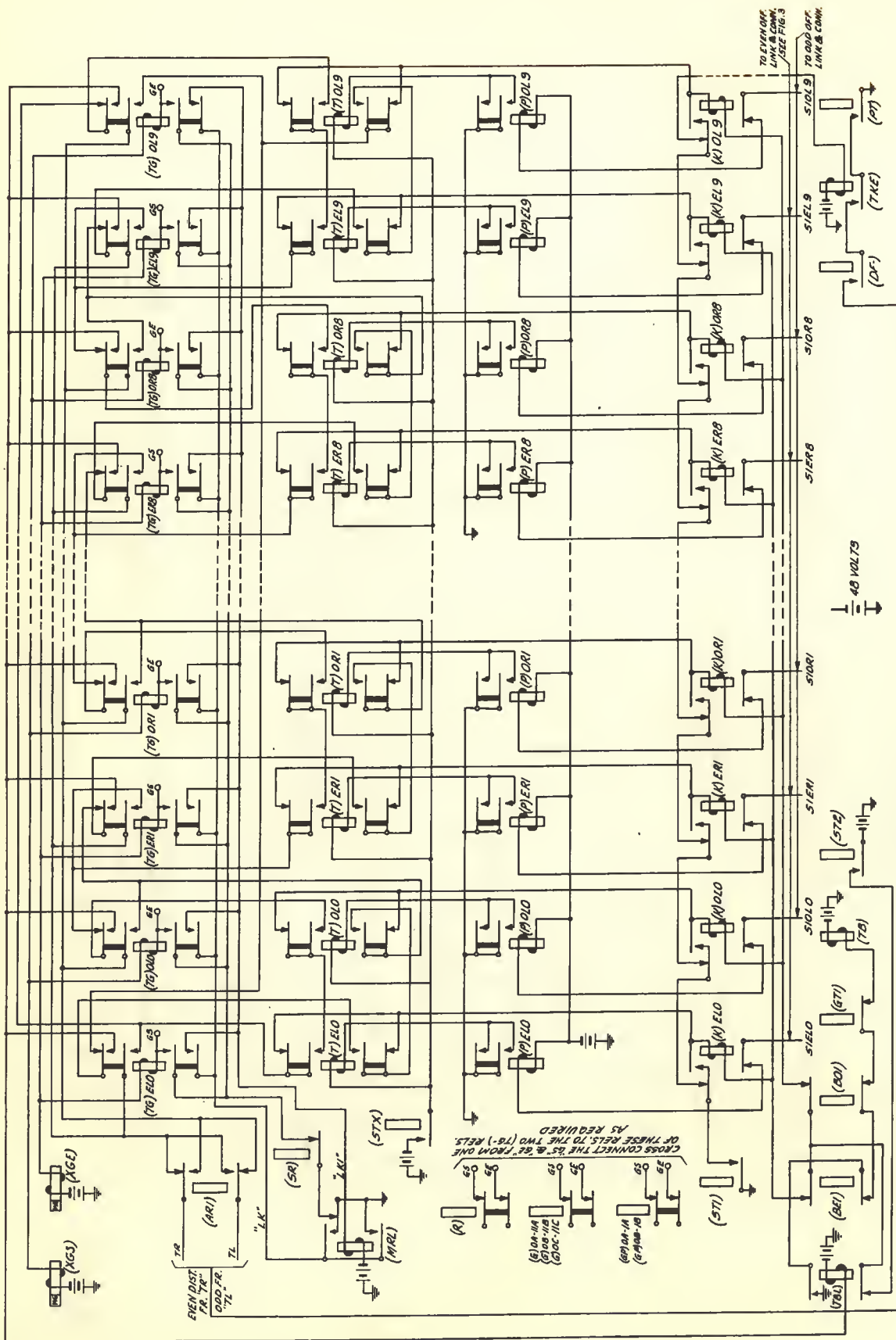


Fig. 4 - Originating Marker - Trunk Group Start and End Also Trunk Selection

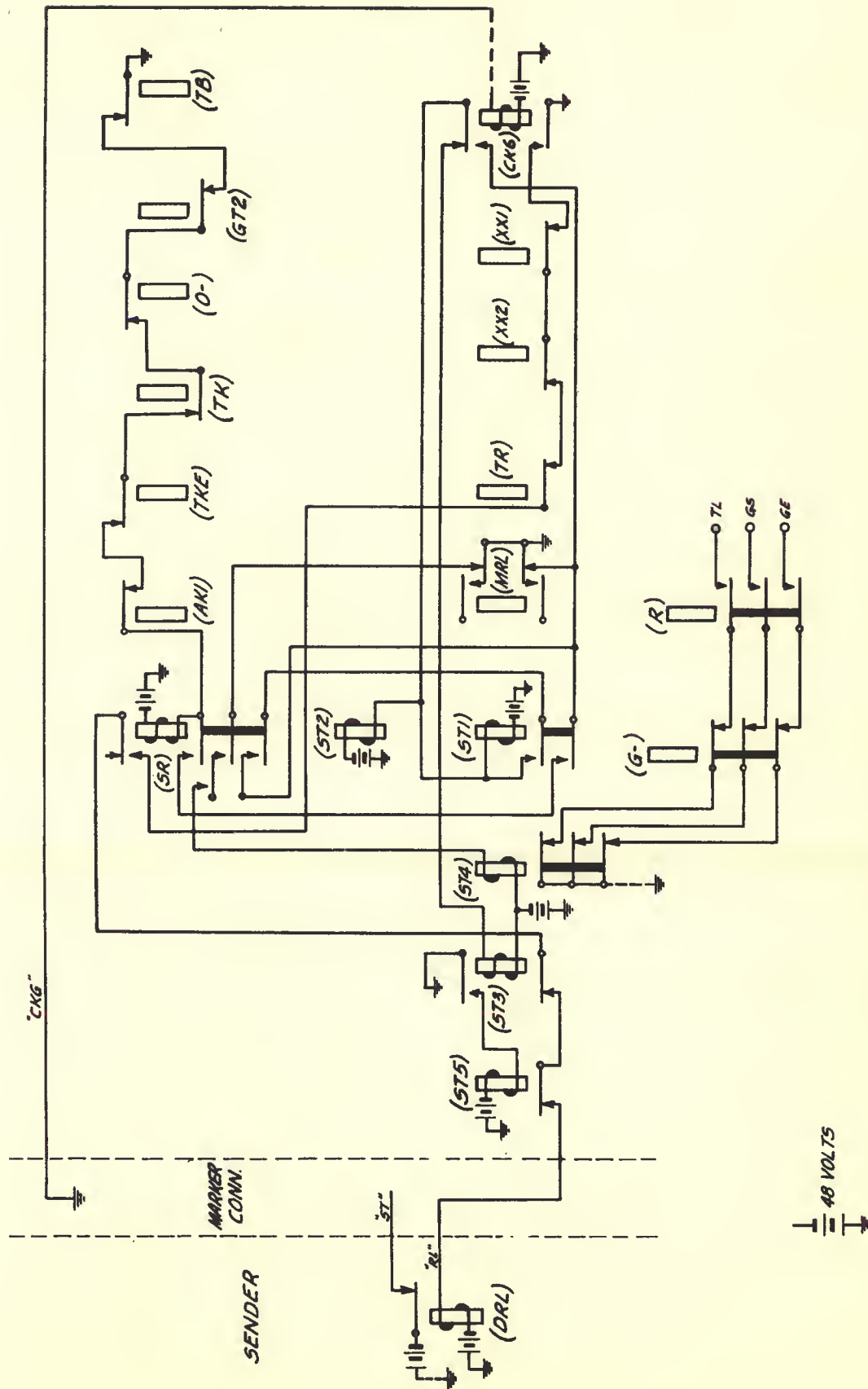


Fig. 5 - Originating Marker - Sender Release on Regular Calls



## CHAPTER 19 - CHANNEL TEST AND SELECTION

Before proceeding to the selection of a channel for completing the call to an outgoing trunk certain checks are made by the originating marker.

### DOUBLE CONNECTION TEST OF TRUNKS USED IN COMMON WITH ANOTHER MARKER GROUP OR PANEL OFFICES

When the (ST1) relay operated, a path was closed which operates the (DT2) relay under control of the (EL), (OL), (ER), and (OR) relays, as shown on Fig. 1. This operates the (DT1) relay. When the (K-) relay operates, the ground that is operating the (DT1) relay is connected to the "S1" lead of the selected trunk. This is to make the selected trunk test busy to another marker group or to panel selectors on trunk groups used in common with panel. The (K-) relay also operates the corresponding (EL), (OL), (ER), or (OR) relay. Assume the first idle trunk to be on the even office frame left side, the (EL) relay would operate. This relay in operating removes ground from the winding of the (DT2) relay, which releases. This in turn removes the operating ground from the (DT1) relay whose winding is now connected through the operated (K-) relay to the "S1" lead of the chosen trunk. If some hunting panel selector which may have chosen the same trunk at the same moment has not grounded the "S1" lead, the (DT1) relay will now release, again connecting busy ground to the "S1" lead from the (S) relay normal.

### CHECK FOR FALSE GROUND ON OFFICE "S" LEAD

The (K-) relay also connects battery through the winding of the (XS) relay to the "S" lead if some trouble condition allows a trunk to be selected as idle and yet there was a ground on the "S" lead, or if this lead should become grounded after the trunk was selected, but before the hold magnet has been operated, then the (XS) relay will be operated and locked. The (XX2) relay will then be operated and the call blocked. The trouble indicator circuit will be called in to take a record of the condition, after which a trouble release signal will be given the sender through the district, except when the sender is asking for overflow. When the (HMT1) relay has released (which will be explained later), the path from the "S" lead to the winding of the (XS) relay is opened.

### RELEASE OF (MCB) RELAY ON MATE OFFICE FRAME

The marker is connected to a pair of office frames by the operation of two (MCA) and two (MCB) relays in the office link and connector circuit. In order to prevent interference while testing for an idle channel from the office frame used, it is

necessary that the (MCB) relay of the frame not in use be released. This is done by opening the circuit through which the (MCB) relay is operated on the contacts of the (EL), (OL), (ER) or (OR) relays. The (EL) or (ER) which operate when a trunk is selected on the even frame, releases the (MCB) of the mate or odd frame, while (OL) or (OR) releases the (MCB) of the mate or even frame.

### OPERATION OF SELECT MAGNETS ON OFFICE SECONDARY SWITCHES

When a split group of trunks is used, two trunks appear on the split level of each office secondary switch, if all levels were split, a secondary switch could serve twenty trunks, ten from the left half and ten from the right half. When none of the levels is split, a secondary switch can serve only ten trunks, since the same trunk appears on the left half level as on the right half of the same level.

A switch may have some levels split and others non-split, but in this case the same levels must be split on all secondary office switches of the pair of frames, and an even number of levels must be split on each switch.

In order to operate the select magnet on the level of the selected trunk, the proper (SS) relay must be operated as shown on Figs. 1 and 2.

When an even level (TL) relay is operated the next higher level (TR) relay is operated and when an odd (TL) relay is operated the next lower (TR) relay is operated. With this arrangement a failure of a particular (SS) relay would only affect half of a group of trunks, served by a particular trunk level on one office link frame.

Assume that the left half trunk appeared on 0 level and the right half trunk appeared on 1 level. If the right half trunk was selected, the "SMR" lead would be grounded, operating relay (SS 1) which in turn would operate the No. 1 select magnet on each of the ten secondary switches. But if lead "SML" was grounded, relay (SS 0) would operate, in turn operating the (0) select magnets of the ten secondary switches. This condition is true when either "TLO" or "TL1" lead is grounded in the marker.

### GAINING ACCESS TO THE PROPER SET OF OFFICE LINKS AND OFFICE JUNCTORS

When relay (K ELO) operated, it indicated that a trunk on the even office frame, zero switch, and left half of the switch had been found idle. The operated (K ELO) relay, also grounded lead "LCO" to the even office link and connector frame to operate the (LCO) relay of that circuit.

## ORIGINATING CHANNEL TEST

When relay (EL) operated, it grounded the "E" lead which is connected through the (CBA) relays, to operate the proper (JC) relay. The (JC) relay when operated, connects resistance battery, through the operated (ST2) relay, to operate one of the district link and connector (JC) relays, as shown on Fig. 3.

Relay (LC-) of the office grounds the "CK" lead operating the (CK) relay. This indicates the "C" or office link sleeve leads are closed through ready for channel test. The operation of the (AK) and (AK1) relays as mentioned in Chapter 18 indicates that "A" or district link sleeve leads are closed ready for channel test. Relay (JC-) grounds the (BK) operating the (BK) relay. This notifies the marker that the "B" or office junctor sleeve leads are closed through ready for channel test.

### DISTRIBUTION OF OFFICE JUNCTORS - LESS THAN TEN DISTRICT AND OFFICE LINK FRAMES

The marker is arranged to route successive calls through from one to five test choices "A" to "E", (depending on the number of district and office link frames involved) in order to distribute as evenly as possible the wear on these circuits. This feature is controlled by the (CBAL-5) and (CBB1-5) relays indicated by (CBAL-5) on Fig. 3 which will not be described in detail. When an idle channel has been found in a particular test choice and the marker is released from the call, the marker (before restoring to normal) sets itself so that when the next call advances to the channel testing stage, the channel will be selected in the next following channel test choice. The calls are successively distributed in turn to the different channel test choices until the last test choice in the cycle is reached, when the next call starts as in the beginning.

When all channels of a test choice are found busy, all of the channel test relays are operated and the particular channel test choice involved is released. Then, the next succeeding channel test choice is selected and a test for an idle channel is made again. If that channel test choice is found busy, the next channel test choice is selected and the preceding one is released until an idle channel is found or until all channel test choices are tested and found busy. If such a condition occurs, the office link frame picked to handle the call is released and the mate office link is connected to handle the call. The process of selecting a trunk and channel on the mate office frame is the same as that followed on the office link just released.

### CHANNEL TEST - CHOOSING AN IDLE COMBINATION OF DISTRICT LINKS, OFFICE JUNCTORS, AND OFFICE LINKS

The twenty "LS" leads from the (LC) relay in the district frame circuit terminate in the secondary windings of the twenty (AB) relays. The twenty "S" paths from the operated (JC) relay in the district frame circuit terminate in the primary windings of the twenty (AB) relays. The twenty "LS" leads from the (LC) relay in the office frame

circuit terminate in the secondary windings of the twenty (C) relays.

It is over these paths that the marker tests to find an idle channel. Channels that are busy have ground connected to one or more of these leads and the (AB-) or (C-) relay corresponding to these busy or non-available channels are operated as indicated and discussed in Chapter 13.

There are less than twenty channels available when there are more than ten district or office frames. In these cases the (C-) relays corresponding to the non-available channel are operated from the pattern relays. There are also less than twenty channels available when the trunk selected is on a split level of the office secondary switch. In these cases the (C-) relays corresponding to the non-available channels are operated from the (SPL) or (SPR) relay. One of these relays is operated from the (EL), (OL), (ER) or (OR) relay if the (SPE) relay is operated indicating that the selected trunk is on a split level.

The pattern (P) and pattern auxiliary (PA) relays are operated under control of the district frame (DF-) relays and the office (O-) relays depending upon the cross-connection provided for the installation. Figs. 4 and 5 show such an arrangement when there are six district link frames and six office link frames. The channels are then blanked out by cross connecting the "BPR-" or "BPL-" leads to the primary winding of the (C-) relay shown on Fig. 3 of Chapter 13.

### SELECTION OF A CHANNEL

The (BK) relay operated as an indication that the channel test paths were closed. The operation of the (BK) relay removes a shunt from around the condenser associated with the (CHT) relay as shown on Fig. 6. Removing this shunt will allow the (CHT) relay to operate slowly, since current will continue to flow through the "S" winding as the associated condenser is charged. This current will decrease, however, as the condenser becomes charged and eventually it will be reduced to a point where the energy in the secondary winding is less than that in the primary winding and finally the (CHT) relay will operate. This provides a delay from the time the (BK) relay operates until the (CHT) operates and is provided to allow time for all (AB-) or (C-) relays to operate if they are going to operate.

With all (CH) relays normal, relay (CHE) operated as soon as relay (ST1) operated and in turn operated relay (HMT1).

When relays (CHE), (HMT1), and (CHT) are all operated, ground is closed through a chain path of the (AB-) and (C-) relay contacts. The first set of these relays encountered which does not have either or both the (AB-) or (C-) relays operated closes a path to their associated (CH-) relay which will now operate and lock. The operated (CH-) relay in turn releases the (CHE) relay.

TIMING FOR RELEASE OF HOLD MAGNETS

The (CHE) relay was operated following the operation of the (ST1) relay. The (HMT1) relay then operated. When the (BK) relay operates following the operation of the district junctor (JC) relay, a path for holding the (HMT1) relay is established through the back contact of the (HMT) relay. When the (ST2) relay is operated, the (HMT) relay is energized on its primary winding and may operate. It will release, however, when its secondary winding is energized following the operation of the (CHE) relay.

The (CHE) relay releases following the operation of a (CH-) relay. The (CHE) relay is made fast release, so that the path from the front contacts of the (CHT) relay over which the (CH-) relay was operated will be opened quickly and prevent the possible false operation of another (CH-) relay, should some (AB-) or (C-) relay, through whose front contact the particular (CH-) relay was operated, release due to that channel becoming idle. If this should occur, it would close the operating circuit to another (CH-) relay. The (CHE) relay released opens the operating ground to the (CH-) relays and opens the operating path to the (HMT1) relay. This relay does not release at this time, however, since it is held through the back contact of the (HMT) relay. The (CHE) relay releasing also removes a shunt ground from

the (HMT) condenser and associated resistance. This ground was energizing the polarized (HMT) relay on its secondary winding in the non-operate direction and this winding is strong enough to hold the relay in its non-operated position, even though it is energized in the operated direction through its primary winding. Removing direct ground from the secondary winding of the (HMT) relay will not allow it to operate immediately, however, since current will continue to flow through the secondary winding as the (HMT) condenser is charged. This current will decrease as the condenser becomes charged and eventually it is reduced to a point where the energy in the secondary winding is less than that in the primary winding and finally the (HMT) relay will operate. There will be a delay then from the release of the (CHE) relay, following the choosing of an idle channel, until the (HMT) relay operates. This relay is provided to permit the release of any district or office hold magnet that may have started to release just in time to permit the marker to select the corresponding channel as idle. Should a hold magnet be energized before it has had time to release and restore the trip finger, two cross points might be closed.

When the (HMT) relay has operated, the (HMT1) relay will release starting the operation of the district primary and office secondary hold magnets in series with the (A) and (C) relays, which will be described later.

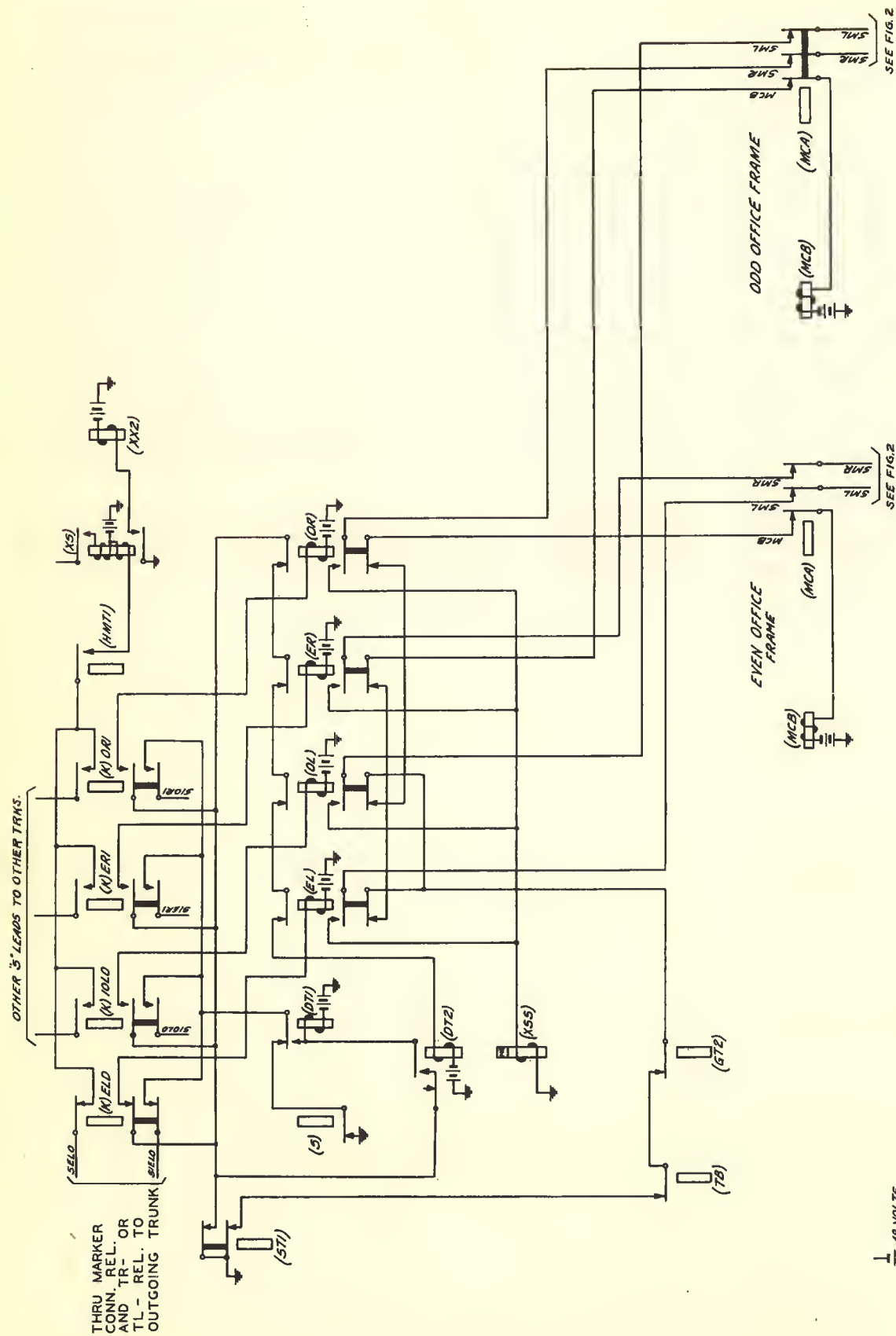


Fig. 1 - Double Connection Test - Check of "S" Lead - Release of (MCB) Relay on Mate Office Frame

OFFICE LINK & CONN.

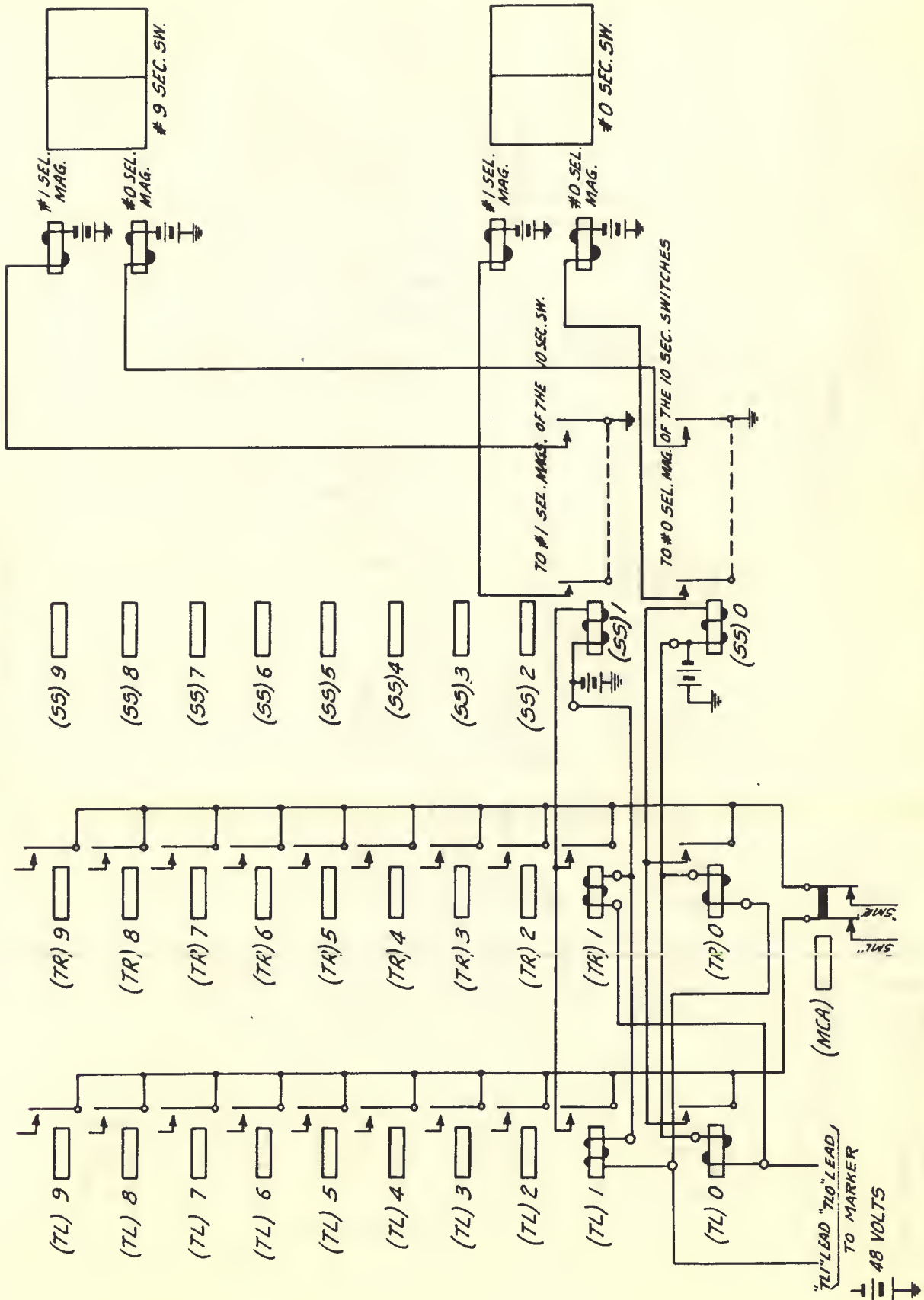


Fig. 2 - Operation of Selecting Magnets on Office Secondary Switches

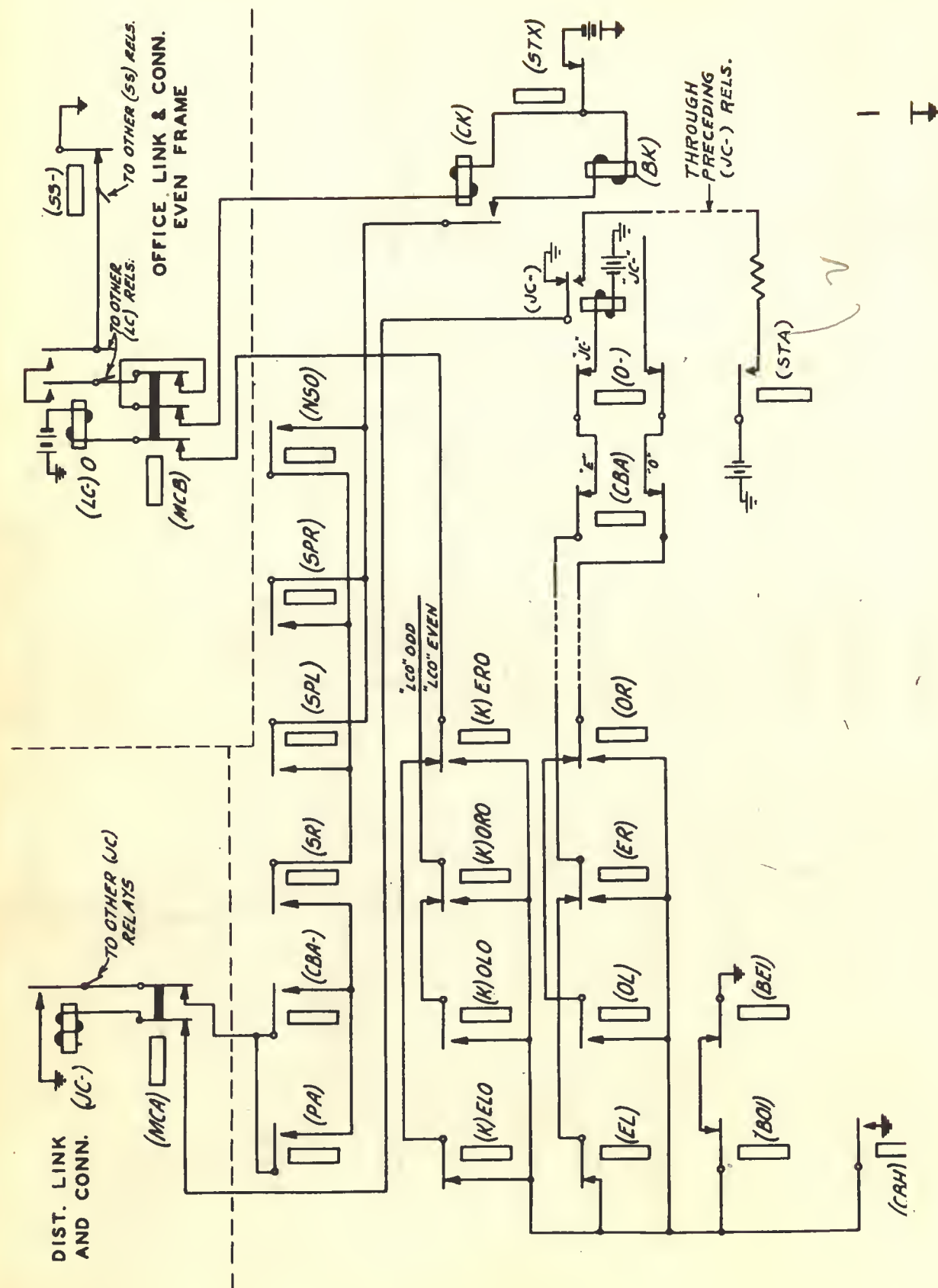


Fig. 3 - Gaining Access to Office Links and Office Juncturs

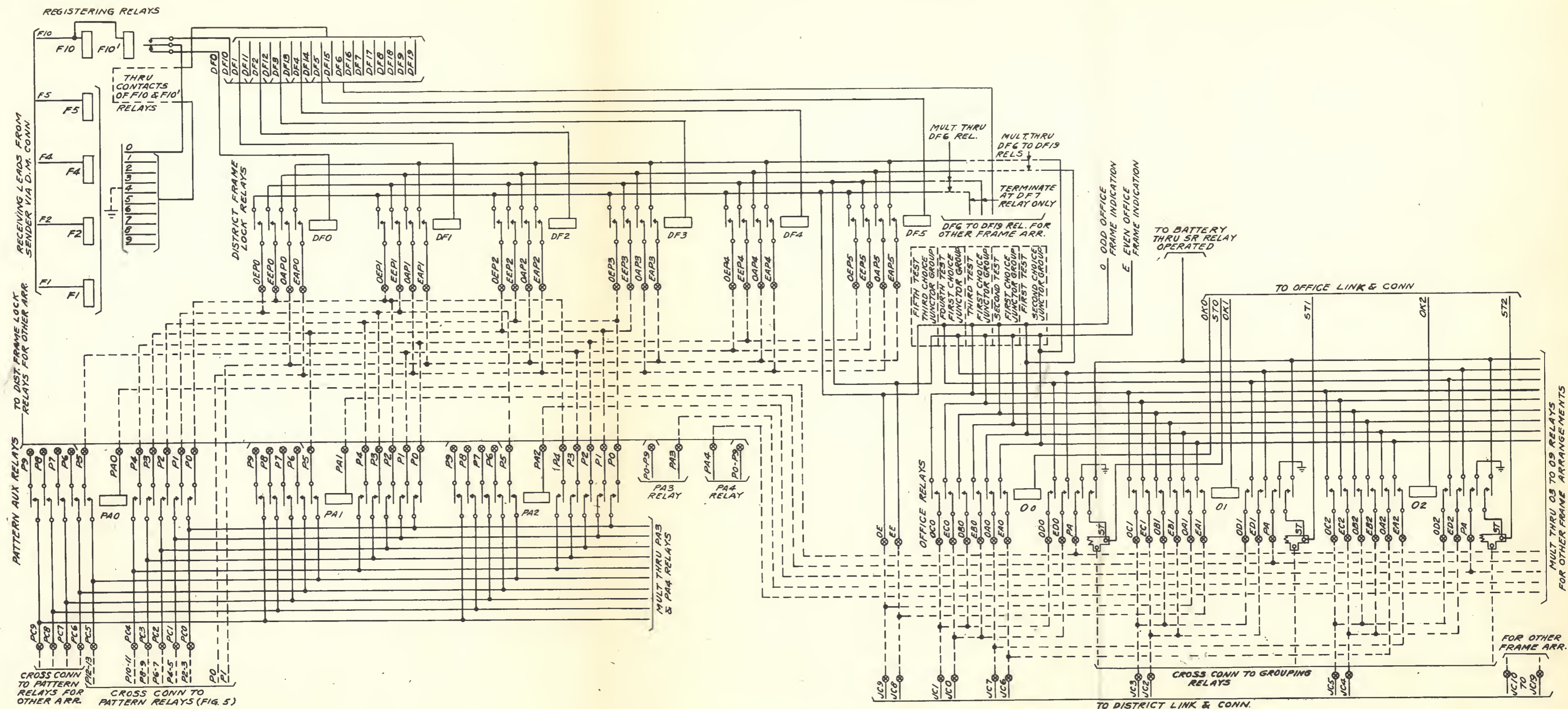


Fig. 4 - Marker Circuit - Six Frame Arrangement - District Frame Lock, Office Frame and Pattern Auxiliary Relays



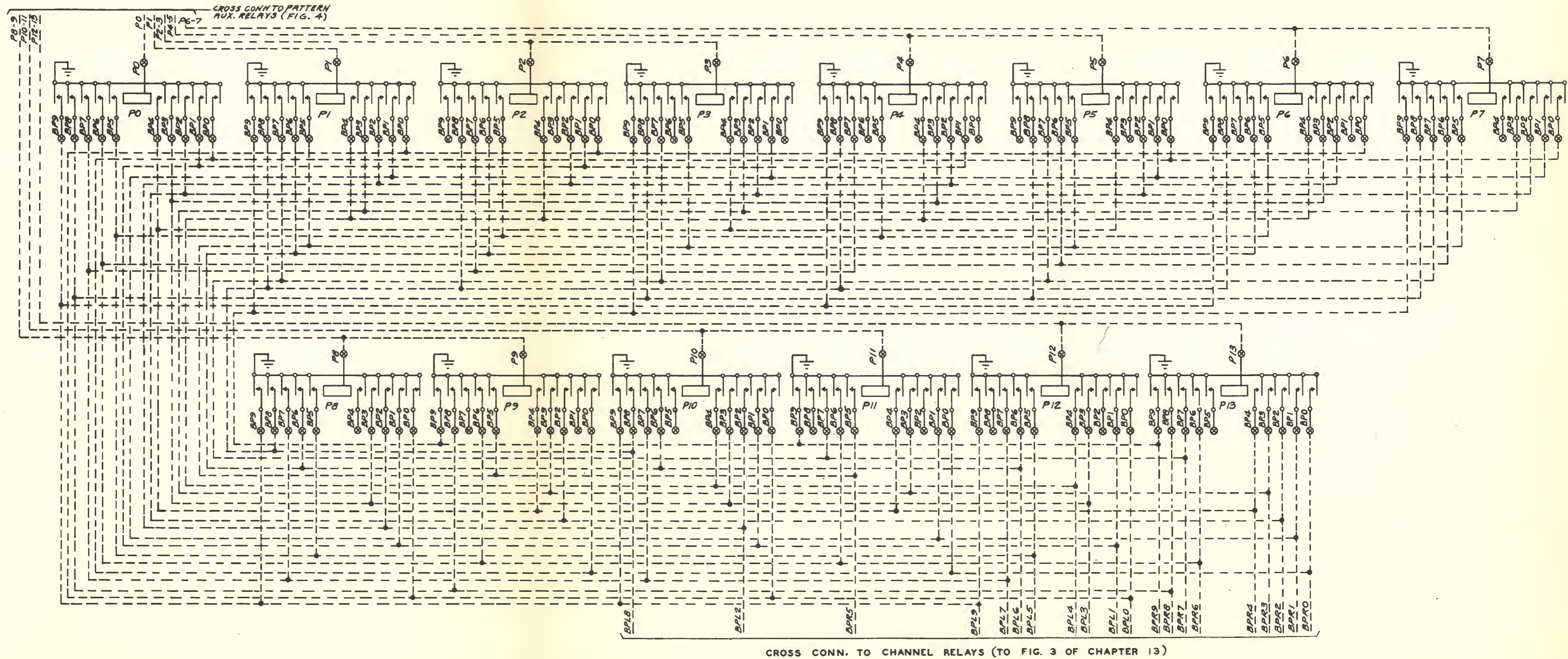


Fig. 5 - Marker Circuit - Pattern Relays - Six Frame Arrangement



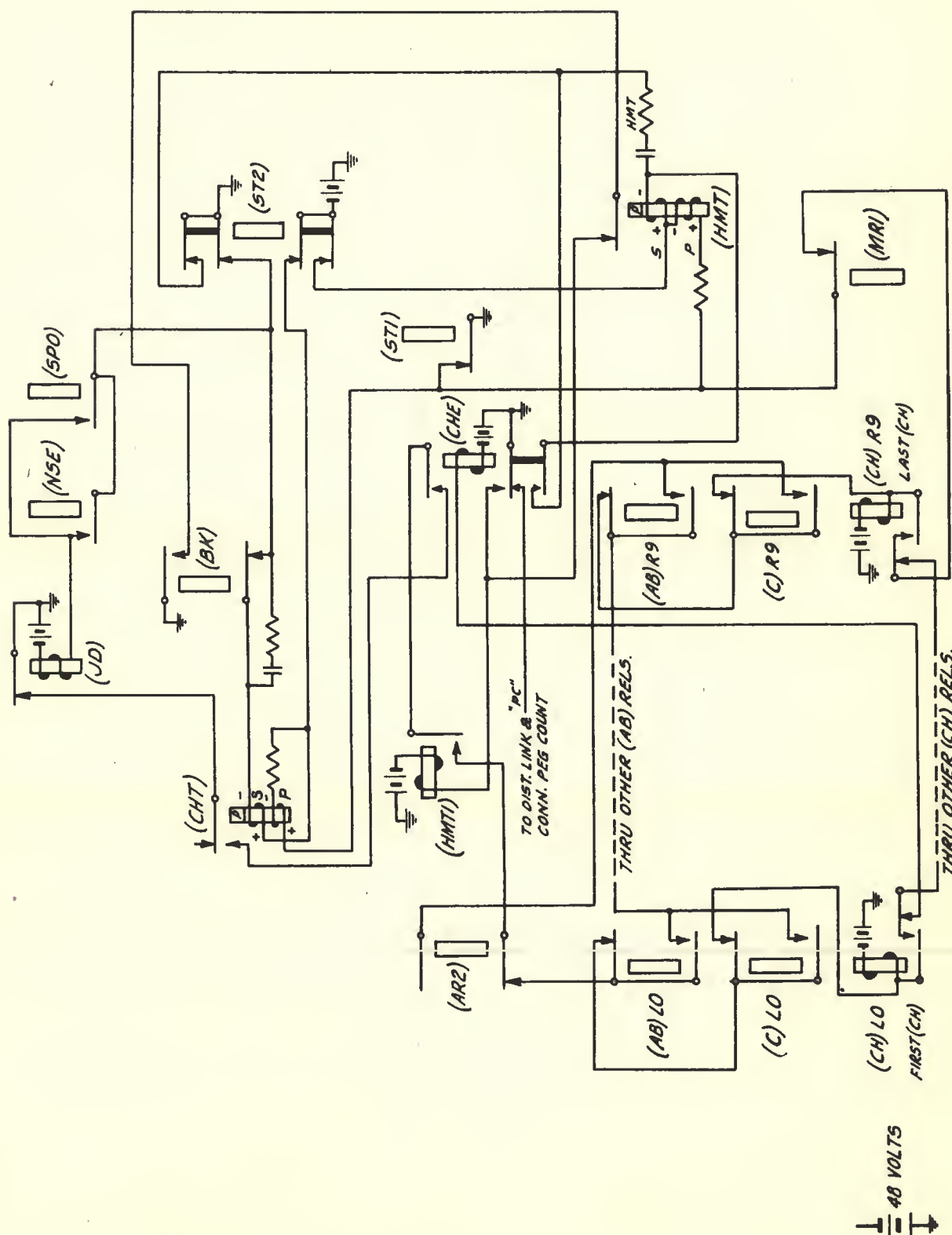


Fig. 6 - Selection of Channel and Timing for Release of Holding Magnets



## CHAPTER 20 - CALL ESTABLISHED TO OUTGOING TRUNK

The charge and transmission conditions are established in the district junctor by the originating marker. This function may be performed any time after the district junctor connection has been established through the district link to the marker as indicated by the operation of the (AK-) relays and before channel selection has been completed.

### RECORDING PARTY INDICATION

Senders that serve 2 party message rate subscriber lines must give the marker an indication of which party is calling, in order that the marker may set the district junctor for charging the party making the call.

The sender passes this information to the marker by grounding the "TP" lead if the tip party of a 2 party message rate line is calling and does not ground this lead if any other class of subscriber or an operator is calling.

When relay (ST1) operates and with the (TP) relay held operated from the sender, the (TP1) relay operates. When the district link has been connected, it holds to the "ZK" lead as shown on Fig. 1. The (TP1) relay causes ground to be connected over the "TP" lead to the district link and connector circuit, when that circuit is finally connected, for the purpose of operating the (TP) relay in the district junctor so that the tip party will be charged for the call. The (AC) relay is operated when the (ST1) relay operates.

If the (TP) relay is not operated in the marker, then relay (RP1) operates and locks. This does not operate the (TP) relay in the district junctor.

### TIP PARTY CHARGE

The district junctor circuits through which calls from 2 party message rate subscribers are completed are equipped with means for charging the tip or ring party, whichever one is making the call. The tip party line message register is operated through the front contacts of the (TP) relay in the district junctor. The ring party line message register is operated through normal contacts of the (TP) relay.

With the (TP1) relay operated, indicating a tip party call, the (TP) relay in the district junctor is operated as soon as the district has been connected. During the period an idle trunk and channel are being selected, the (AC) relay remains operated as shown on Fig. 1. The (TP) relay in the district junctor locks over the "LR" lead to the sender and later to (T) relay in district. The (AC) relay releases after an idle channel has been found and the ground that is locking the district (TP) relay is returned over the "TP" lead operating the (TPK) relay. The

letter K at the end of a relay designation means check., i. e. TPK means to check that the (TP) relay is locked.

### "SL" CHECK CIRCUIT

The check path from the "SL" lead is taken through the contacts of the (TP1), (RP1), and (TPK) relays in such a way that the (TP1) or (RP1) one or the other, must be operated but not both, and when the (TP1) is operated the (TPK) must also be operated. This arrangement is to prevent charging the wrong party on 2 party message rate lines.

When the district is to be set in the cut-through position, as described under "Operator Talking", the (OT) relay in the district junctor is operated so the locking ground for the (TP) relay in the district, which operated over the "TP" lead, is not closed. Therefore, under this condition, it is necessary that the marker cancel the check for the locking of the district (TP) relay. On an operator's call, the (OT1) relay would be operated so that as the (AC) relay releases and with the (TP1) relay operated, the (TPK) relay operates in local circuit.

### TALKING CHARGE

The cross-connections from the route relay winding terminals are provided either direct or through class of service relays contacts to the (TC) relay whenever the calling subscriber is to be charged one message unit.

The (TC) relay is operated in series with the route relay for the purpose of setting the district junctor in the proper charge position. Relay (TC) operated, operates relay (TC1) as shown on Fig. 2. When the district junctor has been connected and while an idle trunk and channel are being found, the (AC) relay remains operated. The "TC" lead from the district is then connected through front contacts of the (TC1) and (AC) relays to ground. This operates the (TC) relay in the district junctor which sets the district for a single charge, when the call is completed and answered. The (TC) relay in the district junctor is not locked until an idle trunk has been found to the desired destination, awaiting the operation of the (DRL) relay in the sender. The (AC) relay releases when an idle channel has been found and then the ground that is locking the district relay is extended over the "TC" lead through a back contact of the (AC) relay to operate the (TCK) relay.

### CHECK OPERATION OF HOLD MAGNETS, ETC.

The "SL" lead from the district over which the "SL" relay must finally operate, is brought

## CONNECTION TO OUTGOING TRUNK

through the contacts of the (TCK) and (ZCK) relays in such a way that one of these relays must be operated, but not both of them. When neither is operated, then the (NCL) relay must be operated. This arrangement checks that the talking charge relay in the district has been properly operated and locked.

## OPERATOR TRANSMISSION

On all codes requiring operator talking condition in the district junctor circuit, the route relay receives its battery through the (OT) relay.

On certain types of operator calls it is necessary that the district be set for operator talking transmission, that is, with the tip and ring leads in the district cut straight through. This requires a ground closure over the "OT" lead from the marker. On such calls, the (OT) relay is operated in series with the route relay as shown on Fig. 3. This operates the (OTL) relay and when the district junctor is connected and, with the (AC) relay operated, ground is connected to the "OT" lead, operating the (OT) relay in the district junctor. When an idle trunk has been found and the sender given a normal release signal, (DRL) relay operated, the relay in the district junctor is locked. When an idle channel has been found, the (AC) relay releases and then the locking ground from the district relay is extended over the "OT" lead, and the (TCK) relay is operated.

## OPERATION OF SELECTING MAGNETS

The district link primary selecting magnet was operated when the district junctor (F) relay was operated. The ten secondary district link selecting magnets were operated by the district link (LC) relay which operated under control of the (F) relay, as described in Chapter 18. The office link primary and secondary selecting magnets were operated by the office link (SS-) and (LC-) relays as described in Chapter 19.

## OPERATION OF THE HOLDING MAGNETS

With a (CH-) relay operated and relay (HMTL) released, the (A) and (C) relays will operate if they encounter the battery through the associated holding magnets as shown on Fig. 4. They will not operate if ground is encountered at the holding magnets. The district primary magnet may operate in series with the (A) relay and the office secondary holding magnet may operate in series with the (C) relay. The (A) and (C) relays having operated, release the (AC) and (AC1) relays which were previously operated from off-normal ground. Relay (AC) having released, closes the district "S" lead to ground from the front contacts of the (AK1) relay through the back contact of the (S) and (SL) relays. This ground causes the operation of the district secondary and office primary holding magnets, each of which in turn extend the ground to the district link and office link, respectively. The district primary and office secondary holding magnets should also operate if not

already operated in series with the (A) and (C) relays. These in turn close the crosspoints extending the ground through to the district "SL" lead and trunk "S" lead.

## CHECK OPERATION OF HOLDING MAGNETS

When the district secondary and office primary holding magnets have operated, the ground that operated these magnets shunts the (A) and (C) relays, which release. With these relays and the (AC1) relay released and all holding magnets operated, a circuit is closed for operating the (S) and (SL) relays. These relays connect ground to the winding of the (A) and (C) relays to hold them in the non-operated position and remove the direct ground to the holding magnets by inserting the windings of the (B) relay. However, ground through the winding of the (B) relay will hold the magnets as well as the (S) and (SL) relays. The (B) relay will now operate in series with the hold magnets and (S) and (SL) relays, provided there is not a false ground on the holding magnet circuit caused by a double connection.

## CHECK "MR" LEAD

When the (AC) relay released, a circuit was closed from battery through the winding of the (MR) relay over the "MR" lead, through the district junctor to ground through the subscriber line message register. On coin and flat rate lines which are not equipped with message registers, the (MR) relay is operated (RMR and ZMR cross connection) from ground through the contacts of the class of service relay (SO-13) depending on the ones used for this class of service. The (MR) should open one of the paths through which the (AK) and (AK1) relays are held, the (SL) relay having opened another while the (B) relay opens the third and last. The operation of the (B) relay releases the (AK) and (AK1) relays.

With the office secondary holding magnet operated, ground is first connected to the sleeve of the out trunk as a busy condition. When relay (S) has operated, this ground is extended to the winding of the (SLK) relay, which operates as a check of the "SL" lead ground.

## SENDER NOTIFIED TO PROCEED WITH CALL

The release of the (AK1) relay removes the ground that was holding the district link (LC) relay, the district (F) relay and the sender (DC) relay which then release. The (F) relay connects ground to the holding magnets. This ground is extended to the winding of the (B) relay and which should now release. The release of the (DC) relay in the sender is the indication for it to establish the connection in the terminating equipment.

## MARKER RELEASE

With the (B) and (AK1) relays released and the (SLK) relay operated, ground is closed to operate the (MRL) relay as shown on Fig. 5. The

(MRL) relay locks under control of numerous operated relays which must release before the (MRL) can release. The (MRL) also releases the (ST1) (ST2), (ST3), (ST4), and (SR) relays. These relays open the office and district start leads. The release of these circuits removes the off-normal battery and ground from the numerous relays that were operated and locked during the marker stage causing these relays to release. The last one to release opens the locking circuit for the (MRL) relay which then releases. With the (MRL) relay released and the (CK6) relay again operated, due to another call having started in the decoder stage, the (ST1) and (ST2) relays will again operate and the next call will advance into the marker stage.

## FULL MECHANICAL TRUNK TEST

The purpose of trunk test is to absorb any electrical charge which might be on the trunk cable which would falsely operate the (STP) relay if trunk test were not made. This condition would most probably occur if the trunk were seized when battery and ground are not connected to the tip and ring or the trunk at the selector end as the selector is returning to normal.

The fundamental is closed when relays (S6') and (F03) are operated as shown on Fig. 6. If the call is skip office call relay (S6') operates upon the release of relay (DC) which occurs when the marker releases the district link having established the connection to a trunk, relay (S6) having operated upon the operation of relay (DC) or upon the completion of distant office selections as shown on Fig. 7. Relay (F03) operates upon the release of relays (F01) and (F02), which occurs when the dialing proceeds far enough to operate the (TH) hold magnet or (H) hold magnet, according to the class of call. The completion of distant office selections, if any, releases relay (S5').

If the trunk is in a group containing non-repeating ground cut-off incomings, relay (MTG) is cut into the fundamental by the operation of relay (CR5) as shown on Fig. 6. Otherwise relay (TG) is used. Whichever relay is used, operates to battery and ground from the distant end of the trunk.

The operation of relay (TG) operates relay (TG1) which in turn operates relay (TG2), or the operation of relay (MTG) operates relay (TG2). Relay (TG2) operates relays (O), (BO), and (FO) through front contacts of relay (S6) and back contact of relay (CL4). These relays prepare the circuit for incoming brush selection.

The purpose of the 14,500 ohm resistance in trunk test is to prevent the line relay of the panel incoming selector or the crossbar incoming trunk from operating until relay (STP) is in the circuit and the sender is otherwise ready to count pulses for incoming brush selection.

## PROGRESS OF THE SELECTION SEQUENCE

On any class of call routed through a 2 wire office selector the (S0) relay is normal. Relay (S3) is operated. The (S3) relay is operated but

(S3') relay is non-operated until relay (DC) releases, indicating that the marker has established a connection to the selected trunk; when relay (S3') operates in series with (S3) as shown on Fig. 7.

When a skip office call is sent, relay (S0) is operated, which operates relay (S6) and then relay (S6') in the same manner as (S3') was operated above.

Every time the (F0) relay operates, it indicates that a fundamental selection has been completed and operates the next (S1-S6) relays in order as shown on Fig. 7. This causes the (F01), (F02), and (F03) relays to function which controls open period of the fundamental circuit between successive selections and releases the counting relays in turn permitting the operation of the prime (S1'-(S6')-10) relay. This releases the pair of (S-) relays previously operated so only one pair is operated at one time. The (S1-S6) and (S1'-S6') relays have additional contacts as indicated on Fig. 8 which are used to operate the (F01) or (F02) relay, control counting relay operation in conjunction with the register circuit and also to close the fundamental circuit.

The sequence relays are operated as follows for the several stages up to and including trunk test:

(S3 - S3')	First office test
(S4 - S4')	First office brush selection
(S5 - S5')	First office group selection
(S6 - S6')	Trunk Test

The sender is arranged to make second office selections but this feature is not shown on Fig. 7.

On a full selector call to either panel or crossbar office, the sequence relays are operated as follows for stages after trunk test:

(S1 - S1')	Incoming brush selection
(S2 - S2')	Incoming group selection
(S3 - S3')	Final brush selection
(S4 - S4')	Final tens selection
(S5 - S5')	Final units selection
(S6 - S6')	Incoming advance

On a PCI call, relays (S6 - S6') remain operated after trunk test throughout the PCI pulsing.

## FUNDAMENTAL SELECTIONS

A typical fundamental selections circuit is shown on Fig. 8. The one here shown is that for office group selection. The details of this operation in the sender are briefly covered in the chart at the lower right hand corner of Fig. 8. The ground commutator pulses are connected to the tip of the office selector to shunt down the (STP) relay in the sender. These commutator pulses are produced as the elevator travels upward as the commutator brush moves across a grounded commutator segment. The elevator travels upward under control of a clutch which is controlled by the (L) relay.

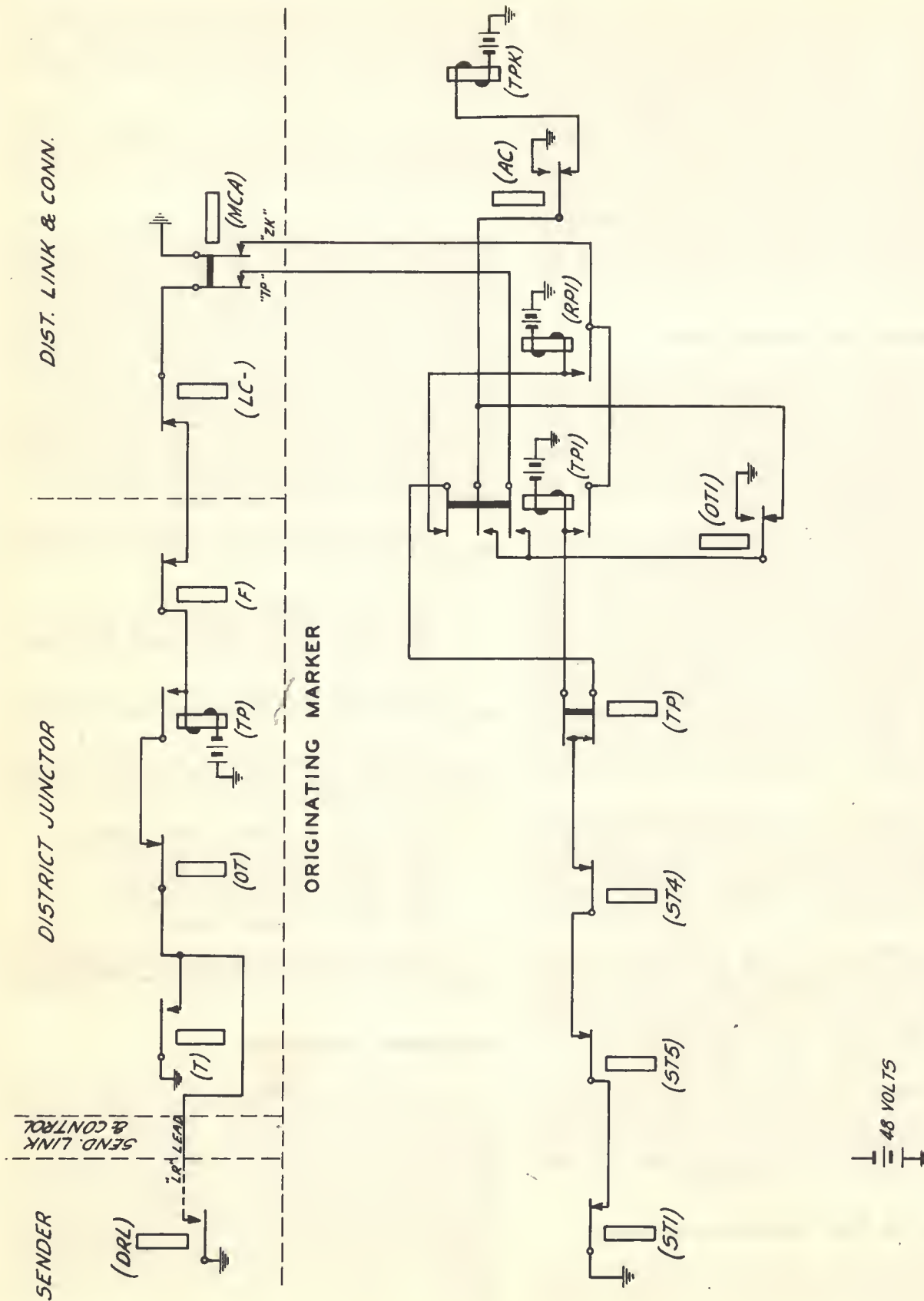


Fig. 1 - Recording Party Indication and Tip Party Charge

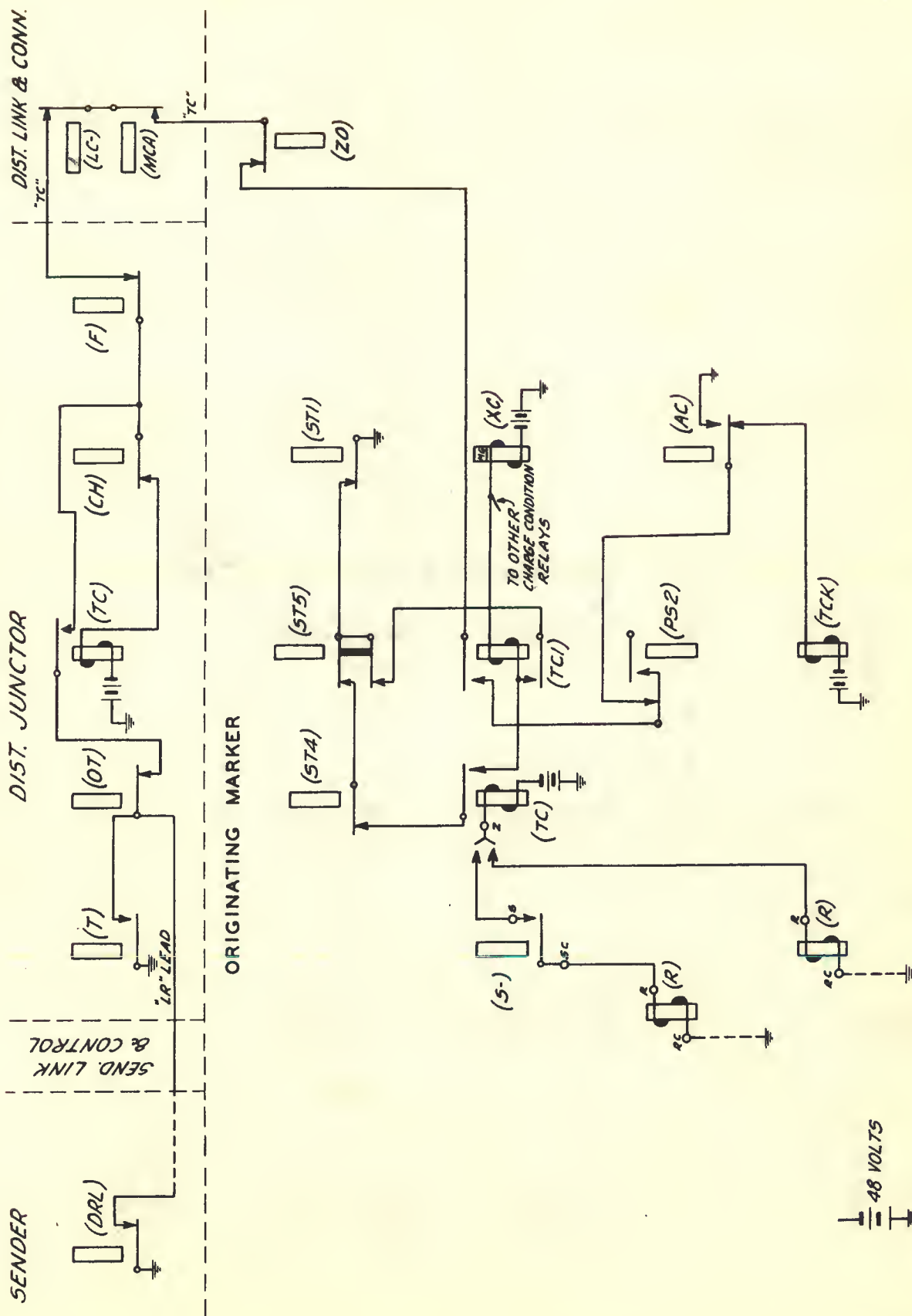


Fig. 2 - Talking Charge

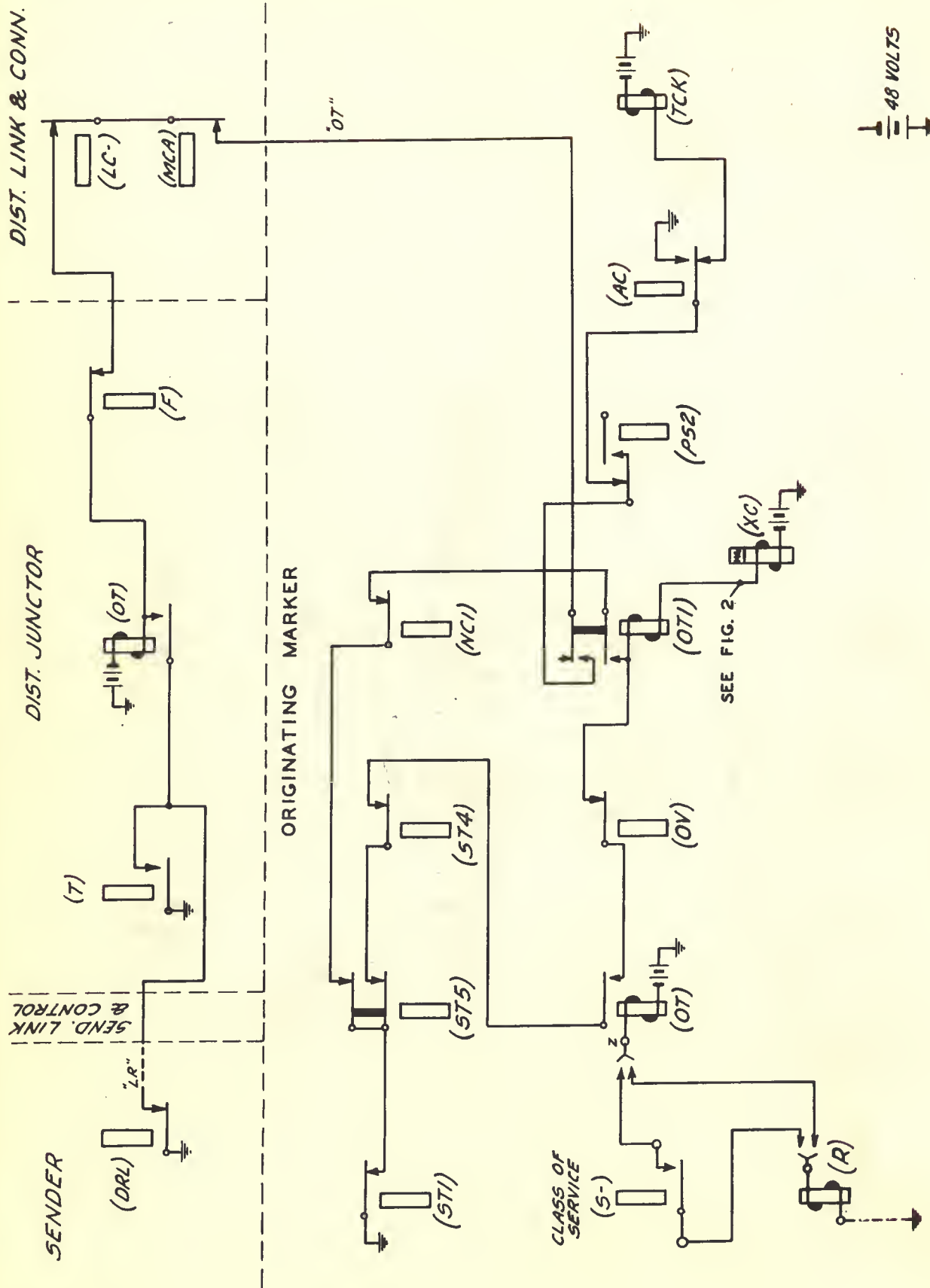
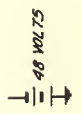


Fig. 3 - Originating Marker - Operator Talk Selection



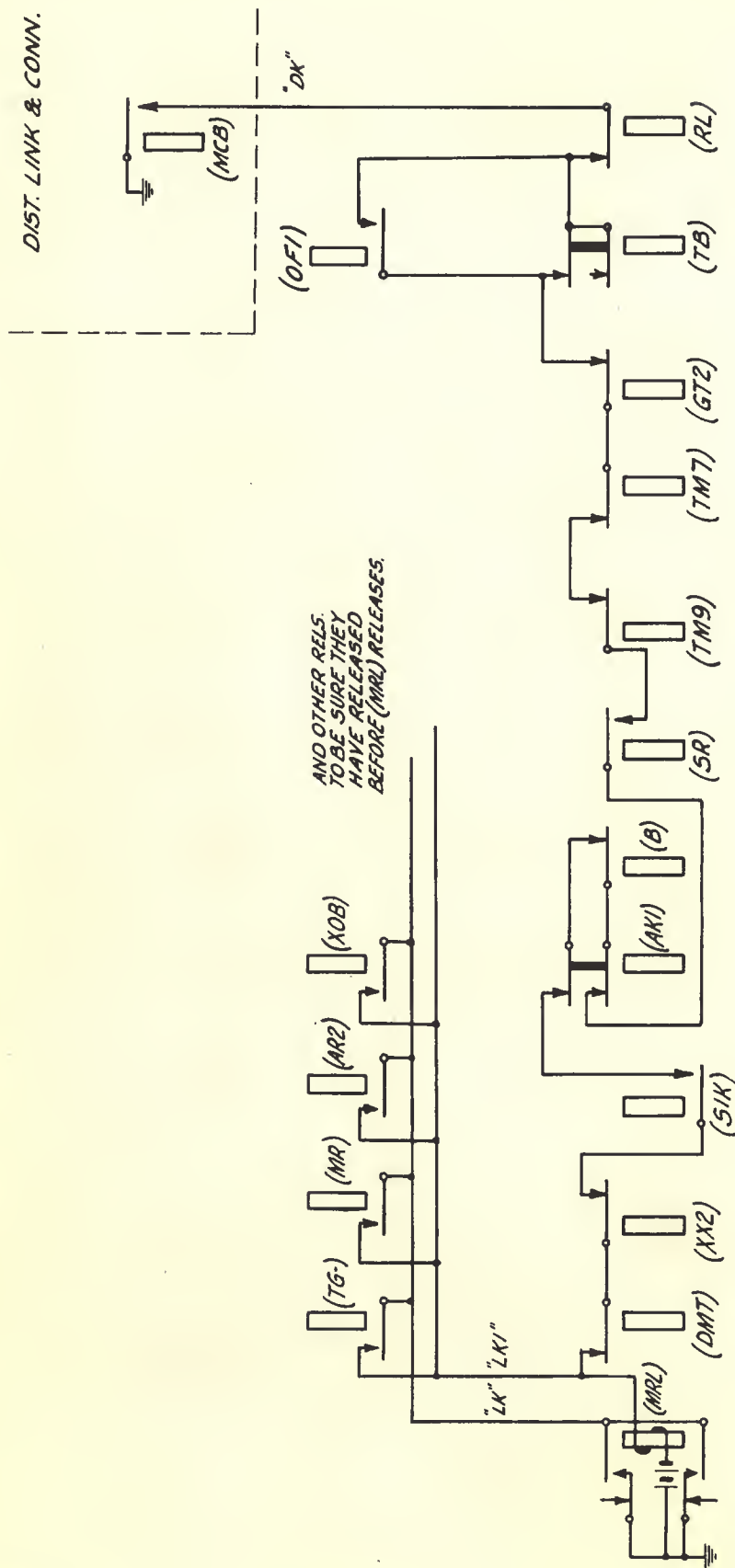


Fig. 5 - Marker Release

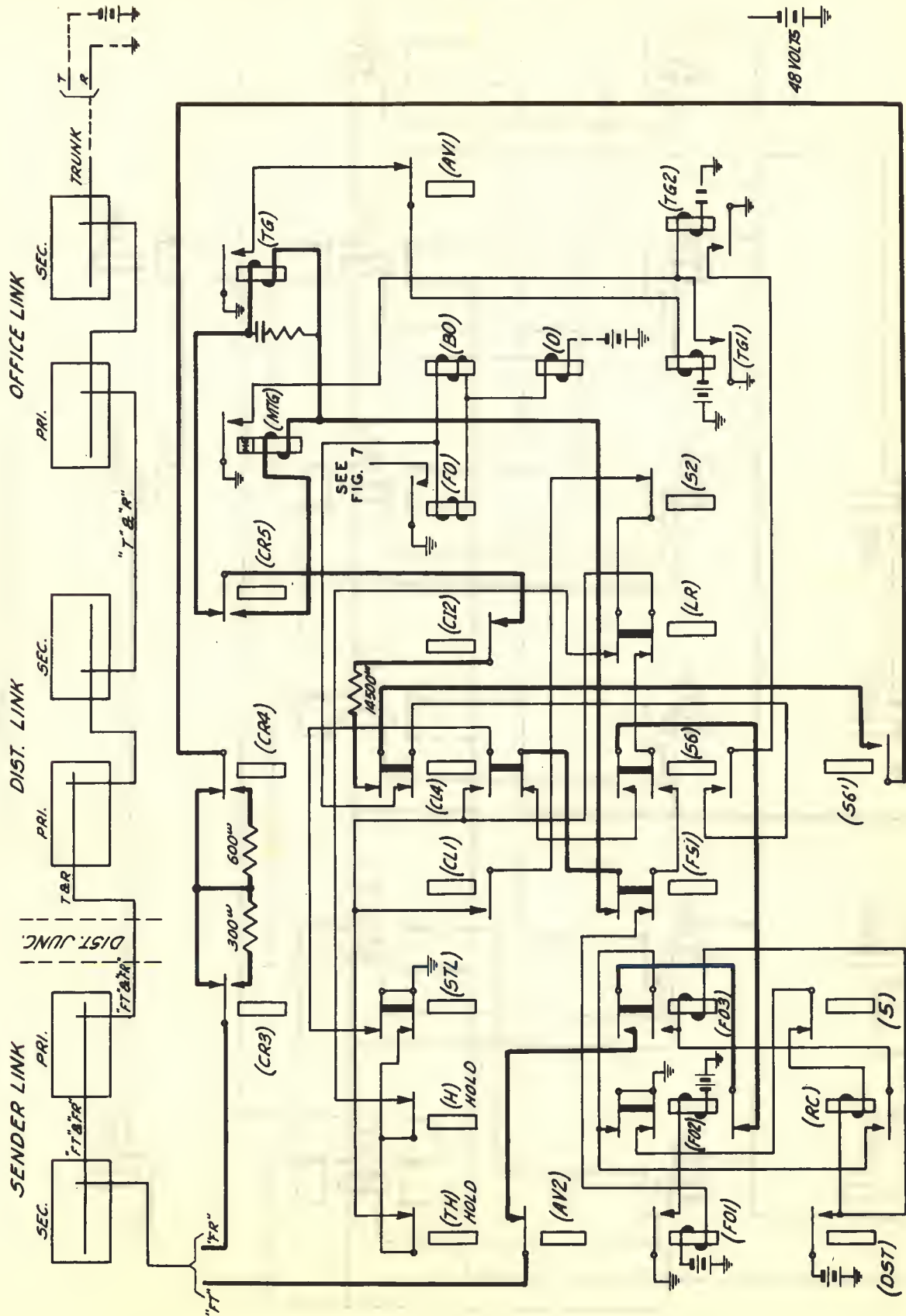


Fig. 6 - Full Mechanical Trunk Test

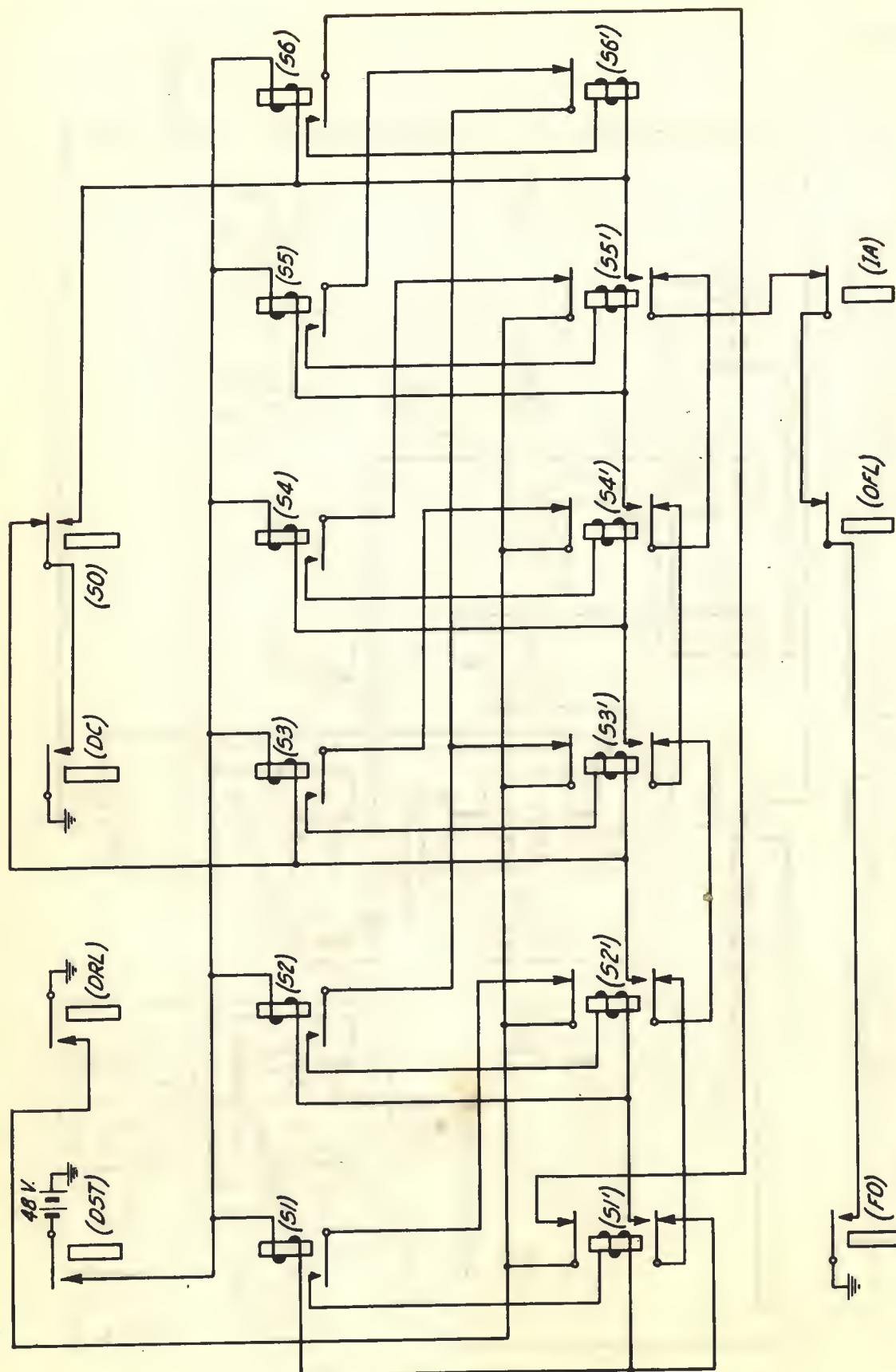
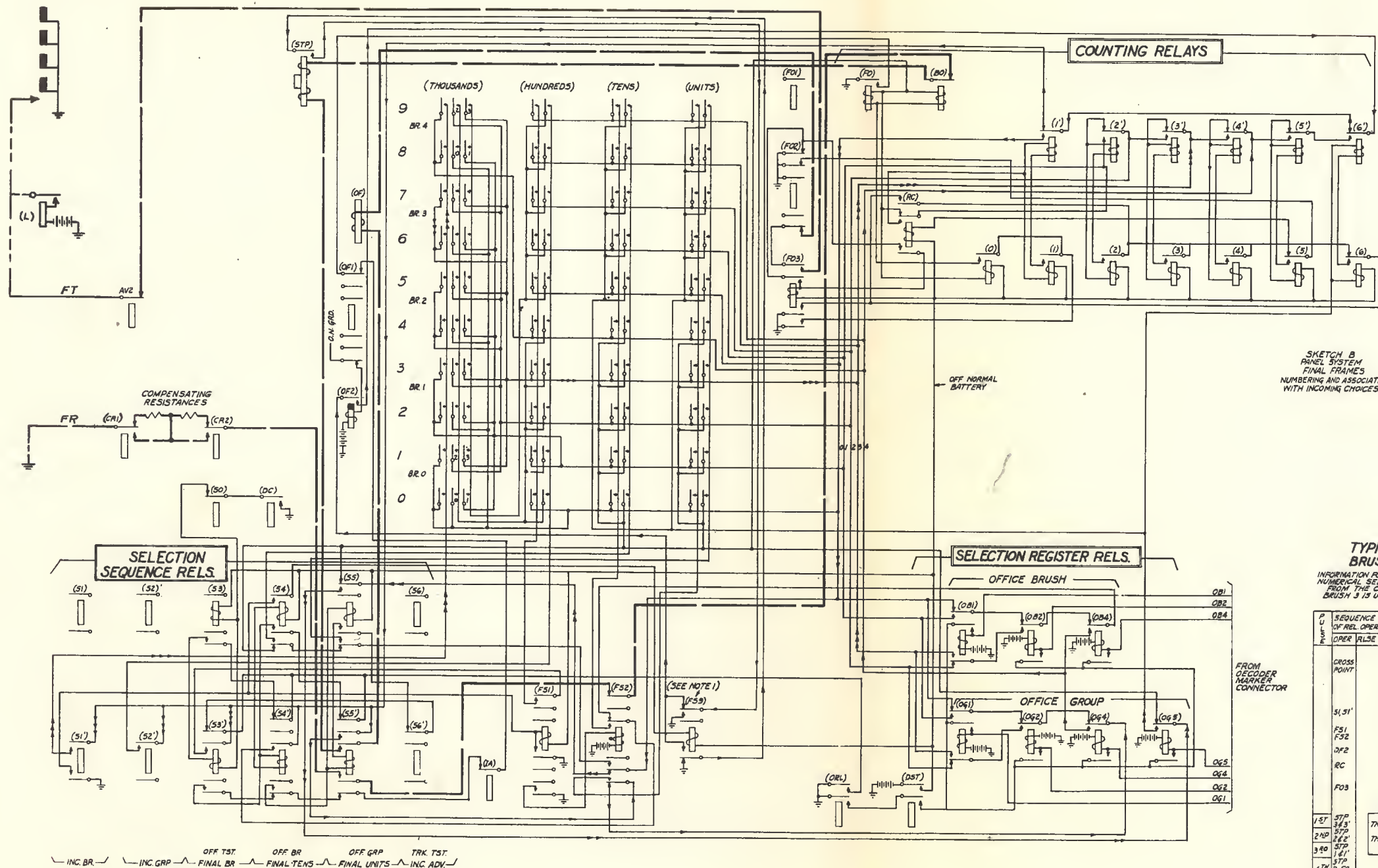


Fig. 7 - Progress of Selection Sequence

OFFICE  
SELECTOR



NOTE 1: F53 OPERATES BEFORE FINAL TENS SELECTION AND REVERSES THE FLOW OF CURRENT THRU STEPPER RELAY CONTACTS TO CONSERVE THE POINTS.

SKETCH A  
PANEL SYSTEM  
INCOMING SELECTOR FRAME  
NUMBERING OF CHOICES

INCOMING BRUSH GROUP	TH	H	T	U
4	3	2	1	0
3	2	1	0	9
2	1	0	9	8
1	0	9	8	7
0	9	8	7	6
9	8	7	6	5
8	7	6	5	4
7	6	5	4	3
6	5	4	3	2
5	4	3	2	1
4	3	2	1	0
3	2	1	0	9
2	1	0	9	8
1	0	9	8	7
0	9	8	7	6
9	8	7	6	5
8	7	6	5	4
7	6	5	4	3
6	5	4	3	2
5	4	3	2	1
4	3	2	1	0
3	2	1	0	9
2	1	0	9	8
1	0	9	8	7
0	9	8	7	6

SKETCH B  
PANEL SYSTEM  
FINAL FRAMES  
NUMBERING AND ASSOCIATION  
WITH INCOMING CHOICES

INCOMING FRAMES	1	2	3 TO 18	19	20
0499	0999		9499	9999	
0400	0900		9400	9900	
0399	0899		9399	9899	
0300	0800		9300	9800	
0299	0799		9299	9799	
0200	0700		9200	9700	
0199	0699		9199	9699	
0100	0600		9100	9600	
0099	0599		9099	9599	
0000	0500		9000	9500	

TYPICAL INCOMING  
BRUSH SELECTION

INFORMATION FOR THIS SELECTION AS WITH ALL NUMERICAL SELECTIONS IS TAKEN DIRECTLY FROM THE CROSSBAR REGISTER SETTING. BRUSH 3 IS USED IN THE FOLLOWING EXAMPLE.

U L S E	SEQUENCE OF REL. OPER OPER. RELS.	LOCK GRD AT	REMARKS
	CROSS POINT		CROSSPOINT 6 OR 7 ON THE THREE SW. VERT SET BY THE SUBS. DIAL AND SIGNIFYING THAT THE COUNTING RELS. SHOULD COUNT OFF & REVERTING PULSES.
	F51		THESE RELS ARE OPERATED FOR THIS PARTICULAR SEL.
	F52		
	RC		OPERS. FROM O.N. GRD
	F03		OPERS. FROM O.N. BATT.
			THIS CLOSING THE FUNDAMENTAL CKT. AS DESCRIBED FOR OFFICE GRP. SELECT.
1ST	STP		PULSES ORIG. AT GRD AT F53 AND FOLLOWS THE PATH DESIG. UNTIL IT REACHES '55' AND THEN FOLLOWS TO THE COUNTING RELAYS.
2ND	STP		
3RD	STP		
4TH	STP		
5TH	STP		
6TH	STP		
7TH	STP		
8TH	STP		
9TH	STP		
10TH	STP		

TYPICAL OFFICE  
GROUP SELECTION

THIS INFORMATION WAS RECEIVED ON THE A, B & C VERTS. OF THE REGISTER SWITCH AND SENT TO THE DECODER WHICH IN TURN OPERATED THE OTHER OFFICE GROUP RELAYS IN THE SENDER. GROUP 3 WILL BE USED IN THE FOLLOWING EXAMPLE.

U L S E	SEQUENCE OF REL. OPER OPER. RELS.	LOCK GRD AT	REMARKS
	55 55		THESE RELS ARE OPER. FOR THIS PARTICULAR SEL.
	064		THESE RELS ARE OPER. BY GRDS FROM THE DECODER IN ORDER TO DIRECT THE COUNTING RELS. TO COUNT OFF 10 REVERTING PULSES.
	065		
	OF2		OPERS. FROM O.N. GRD.
	RC		OPERS. FROM O.N. BATT.
	F03		THIS CLOSING THE FUNDAMENTAL CKT. FOR OFFICE GRP. SELECT. WHICH INCLUDES THE FUND. OFF. SEL. OR CROSSBAR TERM. SDR. THAT WILL SEND REVERTING PULSES TO THE FUNDAMENTAL CKT. IS DESIG. THUS:
1ST	STP		THE FIRST FOUR PULSES ORIG. AT GRD AT F53 AND FOLLOWS THE PATH DESIG. TO THE COUNTING RELAYS.
2ND	STP		
3RD	STP		
4TH	STP		
5TH	STP		
6TH	STP		
7TH	STP		
8TH	STP		
9TH	STP		
10TH	STP		

Fig. 8 - Crossbar Subscriber Sender - Information From Decoder and Progress Through Selections by Counting Revertive Pulses

